ME 4182

MARCH 14, 1985

LUNAR SURFACE SITE PREPARATION APPARATUS

Tim Ayers

Susan Coppedge

Mark Crane

Rich Faglier

Dale Wardall

(NASA-CR-182775) LUNAR SURFACE SITE PREPARATION APPARATUS (Georgia Inst. of Tech.) 79 p

N90-71346

Unclas

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ABSTRACT

This report presents a preliminary conceptual design for moving soil on the lunar surface. The device is not designed for long-term use or designed to meet specific budget requirements. Also, since most of the parts of the device are commercially available, the design looks very much like an earth bulldozer. One astronaut will be able to push lunar soil as well as lift soil and dump it somewhere else. The device will interface and provide power for a core drill and a backhoe attachment. It is assumed that the device will be used primarily for preparing the lunar surface for the construction of a lunar base.

SPECIFICATIONS:

- Outside Dimensions:

  height = 2.59 meters

  width = 2.36 meters

  length = 3.64 meters

- Turning Radius = .3 meters

- Material Specs: Steel: tracks, motor housings, hydraulic cylinders

  housing covering motors, batteries, coolant tank and hydraulic pumps will be sheet metal.

  Aluminum: chassis, brackets and hardware

- Weight = 31,000 Newtons (about 7000 lbs)

- Maximum Power = 35 hp

- Max speed =20

- TRACK: Width = .305 meters

  Length= 2.44 meters

  Height = .76 meters

- BLADE: Width = 2.36 meters

  Height = .70 meters

  Depth of Cut = .33 meters

OVERVIEW

The Lunar Surface Site Preparation Dozer is a tracked vehicle designed to move lunar soil from one location to another, to be lightweight for space travel, and to be interfaced with a backhoe and a core drill.

The machine is operated by an electric - hydraulic system. Rechargeable batteries power two electric DC motors. These motors each power a hydraulic pump and the pumps are connected together to power hydraulic motors to turn the tracks and to position the blade for optimum operation.

The blade is highly versatile as it can tilt from being almost a shaving edge (which aids in traction) to a vertical scraper and can raise a sufficient amount to enable it to carry and dump loads at a specified location.

Operation of this equipment, including the interfaced backhoe and core drill, will be done from a centrally located enclosed cabin on top of the machine by microprocessor aided control arms placed strategically in the arms of a 360 rotating chair. A monitoring system with information from a microprocessor is also incorporated in the chair.

The Lunar Surface Site Preparation Dozer will operate approximately two hours non-stop and can travel at speeds up to 20 miles/hour if necessary. Heat from the electric motors is absorbed by a closed nitrogen blanket system and heat from operating the machine is absorbed by a coolant system. While the batteries are being recharged, the existing coolant will be dumped into a cooling tank and cold coolant will replace the old. This operation will take nearly one hour as the batteries will be recharged with a fast charge that is carefully monitored so that overcharing does not occur. This time may also be used for inspection and small maintenance of equipment if needed.

The Lunar Surface Site Preparation Dozer is designed for a lifetime of one site preparation, but may be used for a longer period if needed. It will weigh approximately 3,187 kg and will push approximately 454 kg on the moon. It is 3.64 m long, 2.36 m wide, and 2.6 m high.

1. TRACKS

The Lunar Surface Site Preparation Dozer was designed with tracks because of their high traction capabilities and will not sink and push as much soil as tires will in sandy soil conditions. These particular tracks are modified John Deere 350 Loader tracks. The modification is the addition of grouser bars which raise the coefficient of friction to approximately .9. They also incorporate self-adjusting hydraulic cylinders for optimum operation in all surface conditions. These tracks are 2.44 m long, .76 m high, and each track shoe is .3 m wide with a track gauge of 1.22 m. The track shoes and its related components are made of hardened steel and the track frame is made of mild steel.

2. BLADE

One of the primary considerations for the lunar dozer blade is versatility. Once the lunar dozer is on the moon it will have to tackle whatever it comes up against, in the form of sand, rocks, etc. The implement that has been chosen for this application was chosen mainly for its versatility. This blade arrangement can function as a bulldozer blade, a scraper blade, or as a loader bucket. The blade may also be provided with teeth for digging or cutting through rock. For normal operation these teeth are covered with a steel plate that can be manually removed as needed. The blade arrangement is pictured in drawings A1 and A2.

The dozer blade is attached to the tractor frame by a C-frame. The C-frame straddles the tractor and is attached approximately two thirds back from the front of the tracks. The c-frame is bolted to the frame by laterally projecting trunnions. These trunnions allow for an up and down pivoting point. The blade and C-frame assembly is raised and lowered by the two main hydraulic cylinders. These main hydraulic cylinders are mounted on pivoting blocks to allow the blade and C-frame assembly to move through the needed arc. The extension and contraction of these main hydraulic cylinders give the blade its depth of cut and the loader bucket the means to be raised and lowered.

The blade has a curved moldboard. This moldboard is supported by channel and ribs to give the blade strength and rigidity. The moldboard is also supported by side plates. These side plates also form the basis for the loader bucket capability. The blade is attached to a pivot in the center of the C-frame. The C-frame is fitted with side channel that slides over the C-frame and attaches to the blade by pivot pins. The side channel and the C-frame are manually adjusted in the horizontal plane. The adjustment holes are locked into place by a pin. With the pin in the middle holes the blade is in its normal operation mode. The blade may be pivoted through an angle of 25° by manually removing the pins and placing one side in the forward most adjustment hole and the opposite side in the rearward most adjustment hole. This adjustment is ideal for grading roadways.

The blade can be rocked about the pivot by the secondary hydraulic cylinder. The secondary hydraulic cylinder should pivot at both ends. A pair of arms are in place to relieve the stress on the secondary hydraulic cylinder. These arms are fitted with a slot. A pin projects laterally through the slot in the arms. The pin acts with the slot to give a stop position in both the forward and rearward most tilt positions of the blade. The blade has three basic operating positions which are ground level upright for grading, ground level forwardly tilted for use as a bulldozer, and raised rearwardly tilted for use as a loader. The versatility of this blade and C-frame assembly should prove to make it the ideal choice for the lunar dozer.

3. HYDRAULICS

The hydraulic pumps are used to power the blade cylinders, the implements, and the track motors. The chosen pumps are gear pumps and therefore the flow rate and pressure depends on the speed. The dozer will use 2 pumps. One pump will run continuously and the other one can be used when additional flow is required. The details are:

2 Rexroth P 2-6 Gear Pumps

Peak	Power Requirement	: 15 hp
	Pressure	: 2000 psi
	Flow rate	: 11 GPM
	Speed	: 4000 RPM

Part Number: P2 - GAH2 - 1 - R

The output from the pumps is combined and fed into a valve body. The valve body is controlled by the output from the microprocessor depending on the commands issued by the operator. Hydraulic pressure is then used to power the bulldozer.

Two hydraulic motors are used to power the tracks and provide mobility to the dozer. The motors are manufactured by Eaton Corporation, and the specifications are:

Series "H" Char-Lynn Hydraulic Motor

6.2 in /rev

Speed: 537 rpm

Flow: 15 GPM (max)

Torque: 868 in. lbs.

Pressure: 1950 psi (Peak)

Part Number: 101-1011

Each motor can operate independently from the other one. This aspect provides the steering for the dozer.

4. COOLING SYSTEM

The hydraulics and the DC motors produce heat that must be removed. A nitrogen blanket cools the DC motors and then dumps heat into the coolant. The coolant itself is circulated around the hydraulics and is stored in a tank under the batteries. When the coolant temperature reaches a critical level, the operator exchanges the hot coolant for fresh coolant from underground. A small electric pump circulates the fluid to all areas. A heat exchanger inside the coolant tank provides the means for dumping heat from the nitrogen.

5. ELECTRIC MOTORS

The Dozer will use two General Electric 20 HP motors. The motors are totally enclosed and fan cooled. The fan will help circulate nitrogen through the motor. The approximate full load ratings for a 96 and 72 volt DC system are as follows:

SYSTEM VOLTAGE	MOTOR CURRENT	RPM	HP
96 VDC	184 A	4707	20.9
72 VDC	184 A	3500	15.0

The maximum speed of the motor is 6500 RPM. The motor can be made to operate clockwise, counter clockwise, or both, but this information must be given to the vendor.

The motors are series wound traction motors. The speed of a traction motor can be accomplished by varying the motor's terminal voltage or the circuit resistance.

The onboard computer monitors the RPM and controls the motor speed. Control of the speed is accomplished by varying voltage input to the SCR control (Silicon Controlled Recitifier). The SCR is made by General Electric and is an EV-1 solid state motor control. The EV-1 uses microprocessor technology to improve the response and voltage range of the motor. The controller card may have to be modified for use with the computer.

The torque on a series wound motor is a function of shaft speed. As the speed decreases the torque increases. The size to torque ratio make it perfect for this application.

The motors are made so they can be bolted directly to the hydraulic pumps.

6. BATTERIES

The power requirements to run our two 20 hp DC motors are 374 Amps and 96 Volts. The batteries to provide this power must be sealed to the environment and require no addition of water. The batteries must also be secondary batteries; batteries that can be recharged many times. To meet the above requirements, Nickel-Cadmium batteries were selected because of their excellent ability to be recharged and because they require no maintenance.

BATTERIES:

General Electric Model # GR4.0

Description: rectangular Sealed Nickel Cadmium Battery

Nominal Voltage: 1.25 V

Internal Resistance: 4 mΩ

Rated Capacity: 4 Amp-hrs

Dimensions: Height=2.921 in
Width=2.37 in
Thickness=.642 in

Weight: 6.7 ozs / each

Continuous overcharge rate: Max=400 mA
Min=200 mA

To achieve 374 Amps and 96 Volts for a two hour period 15,040 batteries will be used. The total weight will be:

6,298 lbs on earth

1,050 lbs on the moon

The batteries will be charged by electricity generated from photovoltaic cells at a fast charge rate. Fast charge rate is when batteries are charged at a rate equal to their rated capacity. This enables them to be charged within one hour. When charging by the fast charge method, the fast charge rate must be discontinued as soon as the batteries are charged to their capacity. Therefore a current sensing device would be connected to the batteries and the charger. This sensing device would cause the charge rate to automatically switch to the continuous charge rate when the batteries have reached rated capacity.

7. SOLAR CELLS

The batteries will be charged with electricity generated from solar cells. A solar cell is a device which convertds the energy of sunlight directly into electrical energy.

The solar cells will be Hughes LPE GaAs cells manufactured by Hughes Research Lab. With an estimated irradiation of 140 MW/cm^2 on the lunar surface, the solar cell has the following characteristics:

SHORT CIRCUIT CURRENT:	I = 32 mA/cm^2
OPEN CIRCUIT VOLTAGE:	V = 1070 mV at T=-30°C
	V = 620 mV at T=200°C
MAX POWER CURRENT:	I = 28.5 mA/cm^2
MAX POWER VOLTAGE:	V = 882 mV at T=-20°C
	V = 470 mV at T=200°C
MAX POWER:	Pmax=25.8 MW/cm^2 at T=-20°C
	Pmax=15.6 MW/cm^2 at T=200°C

Since we need 374 Amps to charge our batteries at a fast charge rate of one hour, the area of the solar cells would be:

13,123 cm^2 = 1.3 square meters.

8. CONTROLS

The lunar dozer uses a two microprocessor based system. The one microprocessor will be used in the form of an on board computer. The other will be used in a Data Logger.

The Data Logger is responsible for the processing and recording of the dozers critical functions. This data will be useful in the evaluation of the dozers performance. The Data Logger will also relay signals to the onboard computer and the instrument cluster. The input signals to the data logger should be 0-15 mV. The signals will be passed to the computer and the instruments and will be amplified into the 0-5 V DC range. The Data Logger monitors and records:

1. All Temperatures
2. Motor Speed
3. Motor Current
4. Motor Current
5. Percent Power
6. Battery Voltage

The Data Logger will send an alarm to the computer if:

1. The trip level on any temperature is reached
2. The maximum motor speed is exceeded
3. The maximum current rating is reached.
4. The motor voltage is not in the required range
5. The battery voltage drops below 72 Volts.

The computer plays an important part in the control of the dozer. The computer handles alarms, speed, and direction of the dozer.

The computer issues an audible warning to the operator if any of the operational limits on critical equipment are reached. Most of the alarms are triggered by the data logger, but the computer does monitor signals not being recorded (ie. percent stall torque). In the event an alarm is issued, the computer will continue to monitor the alarm and will automatically take the appropriate action if the alarm is not cleared. If the computer is not successful in correcting the problem the dozer will be shut down by the computer. In the event of a computer malfunction, the computer can be overriden by a manual switch. However, the operator will no longer have use of the audible warnings or the use of the blade. The motor speed will be set to 4000 RPM, which is in the normal operating range. The direction of the dozer must then be changed by manual means.

In addition to monitoring the Data Logger for alarm signals, the computer will:

1. Perform a check on all critical functions before the dozer can be moved.
2. When the pre-check has been completed the operator will be told.
3. Prevents the operator from doing anything harmful to the dozer or to himself.
4. Controls the motor speed.

* NOTE: The computer has the ability to test itself and warn the operator of any problems. The dozer carries spare computer cards, which can be changed out easily by a person in a space suit.

9. INSTRUMENTATION

The dozer has three types of instruments: visual, audible and some transparent to the operator. Most of the instruments will be monitored by the computer or Data Logger. The only exceptions will be the power and computer override. A drawing of the visual environment layout is provided (See drawing labeled Instrument Panel).

The Visual Instrumentation consists of:

1. 3 Bar Graphs: % Rated Torque
   % Full Power
   Blade Position
2. 4 Digital Temperature Displays
   Motor Temperature
   Hydraulic fluid temperature
   Nitrogen Temperature
   Coolant Temperature
3. 1 Digital Pressure Display:
   Hydraulic Pressure
4. 1 Digital Voltage Display:
   Battery Voltage
5. 1 Digital Current Display:
   Motor Current
6. 1 Digital Speed Display:
   Motor Speed
7. 1 Level Display:
   Dozer Attitude

8. 5 LEDs:

Computer override

Power On

Computer On

Motor 1 On

Motor 2 On

The Audible Instrumentation will come from a speaker in the operators helmet. There is a Jack provided to make the necessary connection on the right arm of the chair. The audible instruments will let the operator know the dozer is ready for operation upon start-up. They will also allert him of problems if the need arises.

The transparent instrumentation consists of lunar temperature and run time. This information can be obtained from the Data Logger.

10. OPERATING INSTRUCTIONS

A. The Emergency Stop Switch

1. Flip up the protective cover located on the left arm of the chair.
2. Depress the Red Button

This will cause the dozer to stop lock itself in place and cut to the electric motors. It will not cut power to the Data Logger or the computer. The dozer will stay locked up until the problem has been corrected and the switch reset.

B. Emergency Brake

This can be operated by:

1. Open the compartment on the right arm
2. Locate pump handle
3. Pump until desired pressure is obtained
4. The Hydraulic Pressure can be released by flipping the switch located at the front of the compartment.

C. The Audio Alarm System

1. Plug the cord from the operators helmet into the jack on the right arm of the chair.

This will automatically activate the alarm system and a "welcome aboard" will be given, which will indicate the system working.

D. The Chair

the chair can be rotated clockwise or counter clockwise by the two foot pedals located at the base of the chair. Depressing the right pedal will rotate the chair clockwise. Depressing the left pedal will rotate the chair counterclockwise.

E. The Instrument Display

The instrumentation is activated when the main power is cut on. The display box can be manually raised and lowered by pushing or pulling on the handle located on the right side of the box. This will accomodate operators or different heights. The box can then be tilted to prevent the sun from hendering the reading of the instruments.

F. Speed and Direction Control

The speed and the direction of the dozer is controlled by a stick located on the left arm of the chair. Push the stick in the direction you wish to go, and you are off. The harder you push, the faster you go.

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6. Whipple, L. Orbiting the Sun. University Press. 1981.

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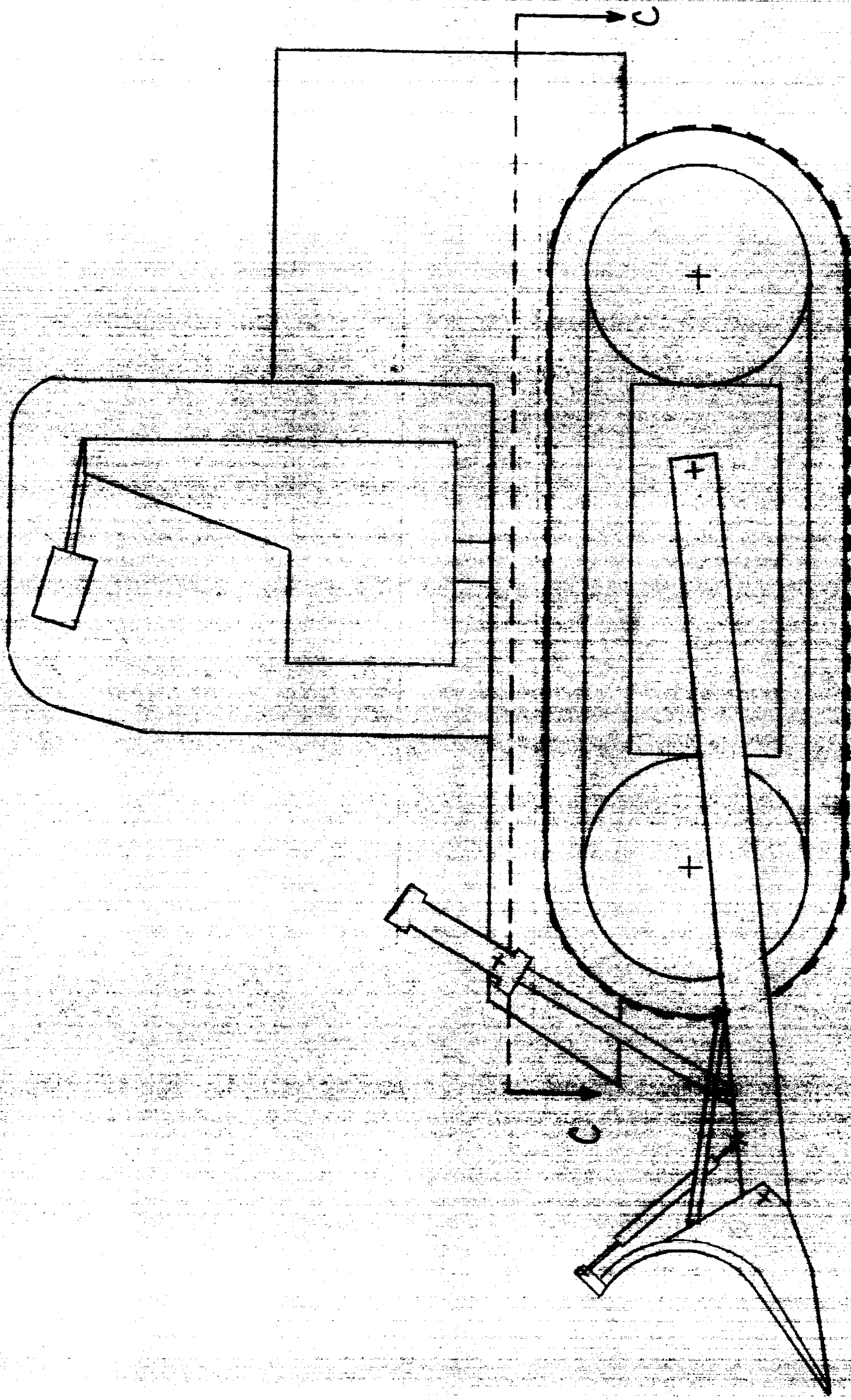
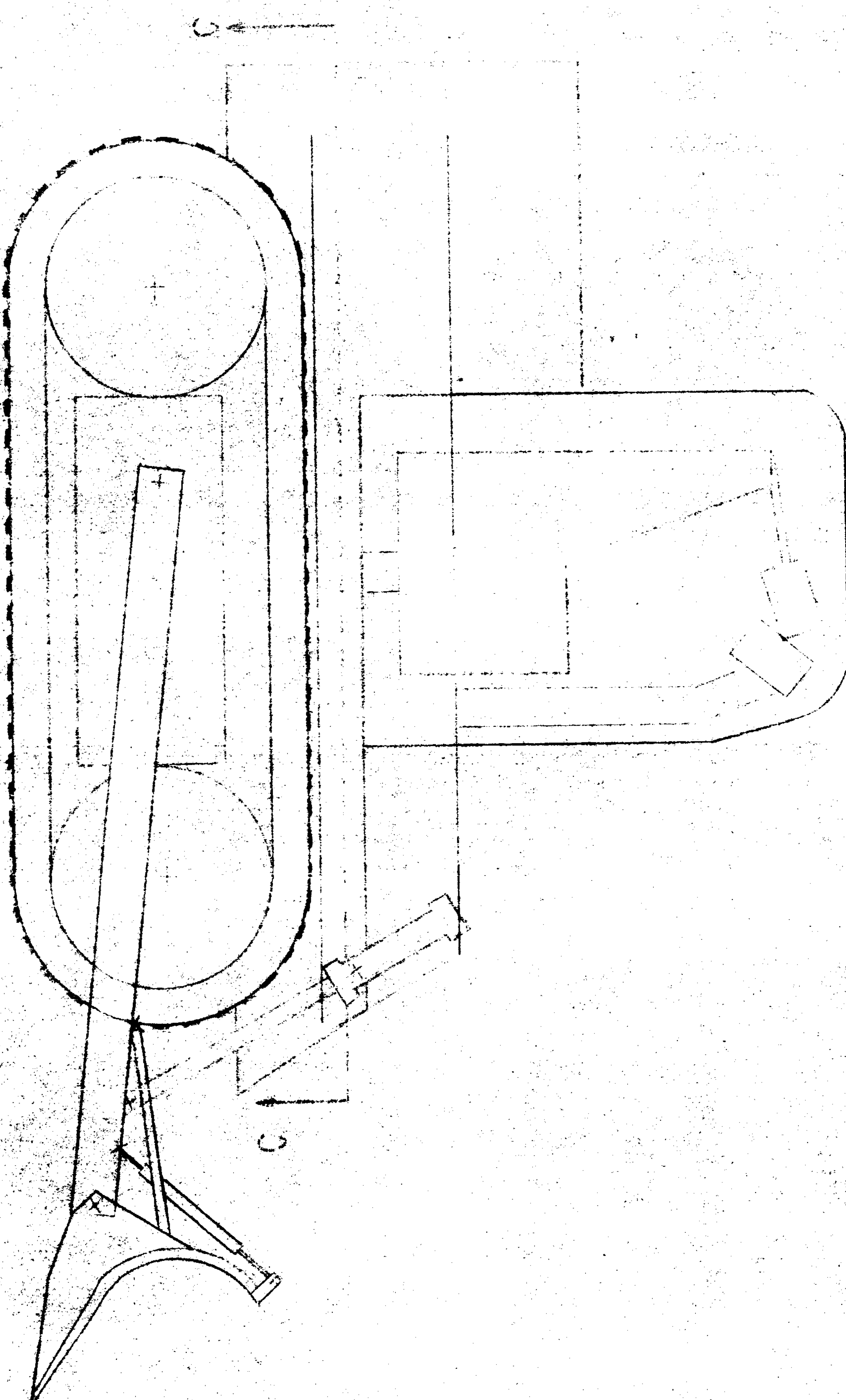


LUNAR DOZER
SIDE VIEW
SPC 2/25/85



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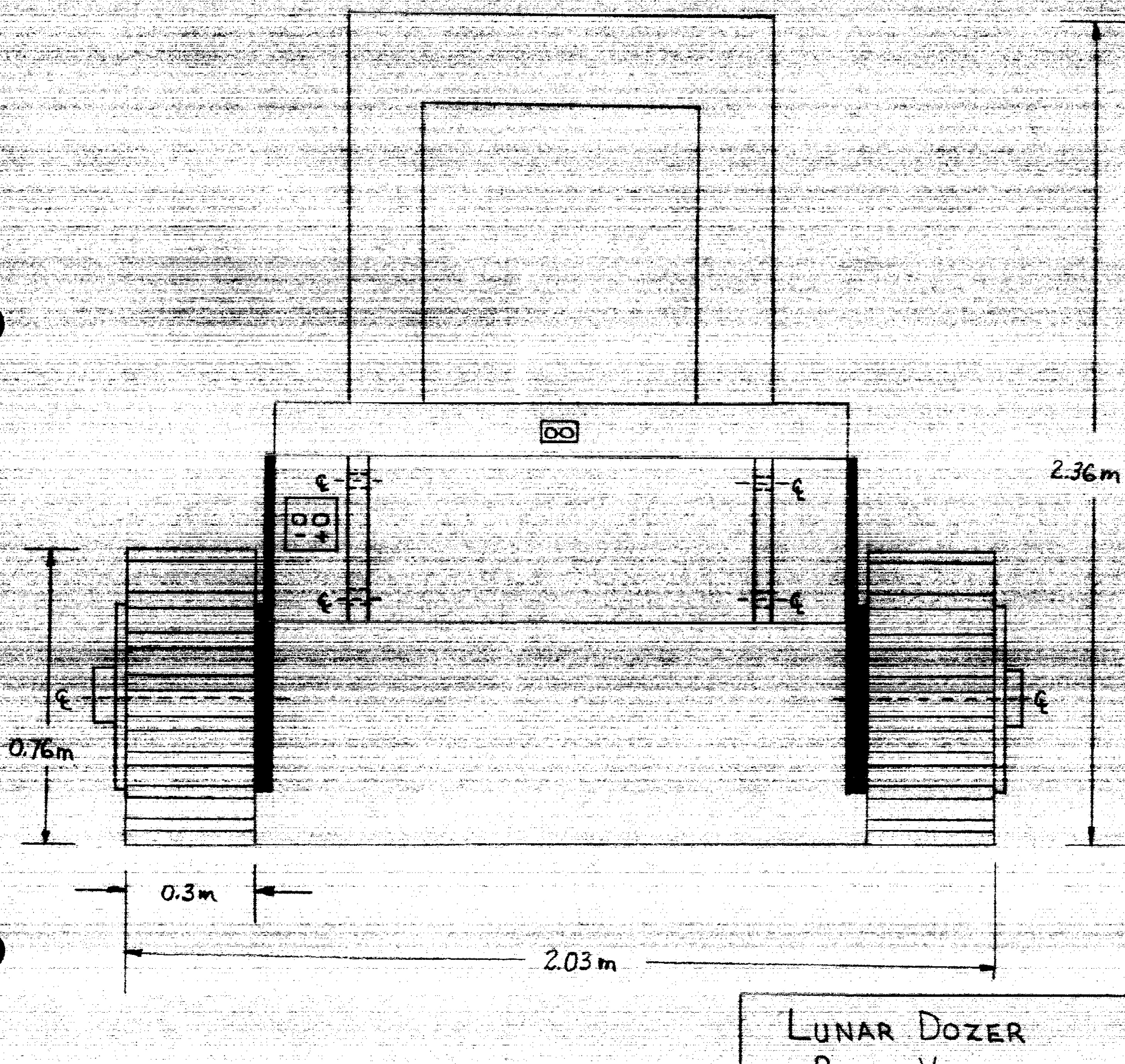
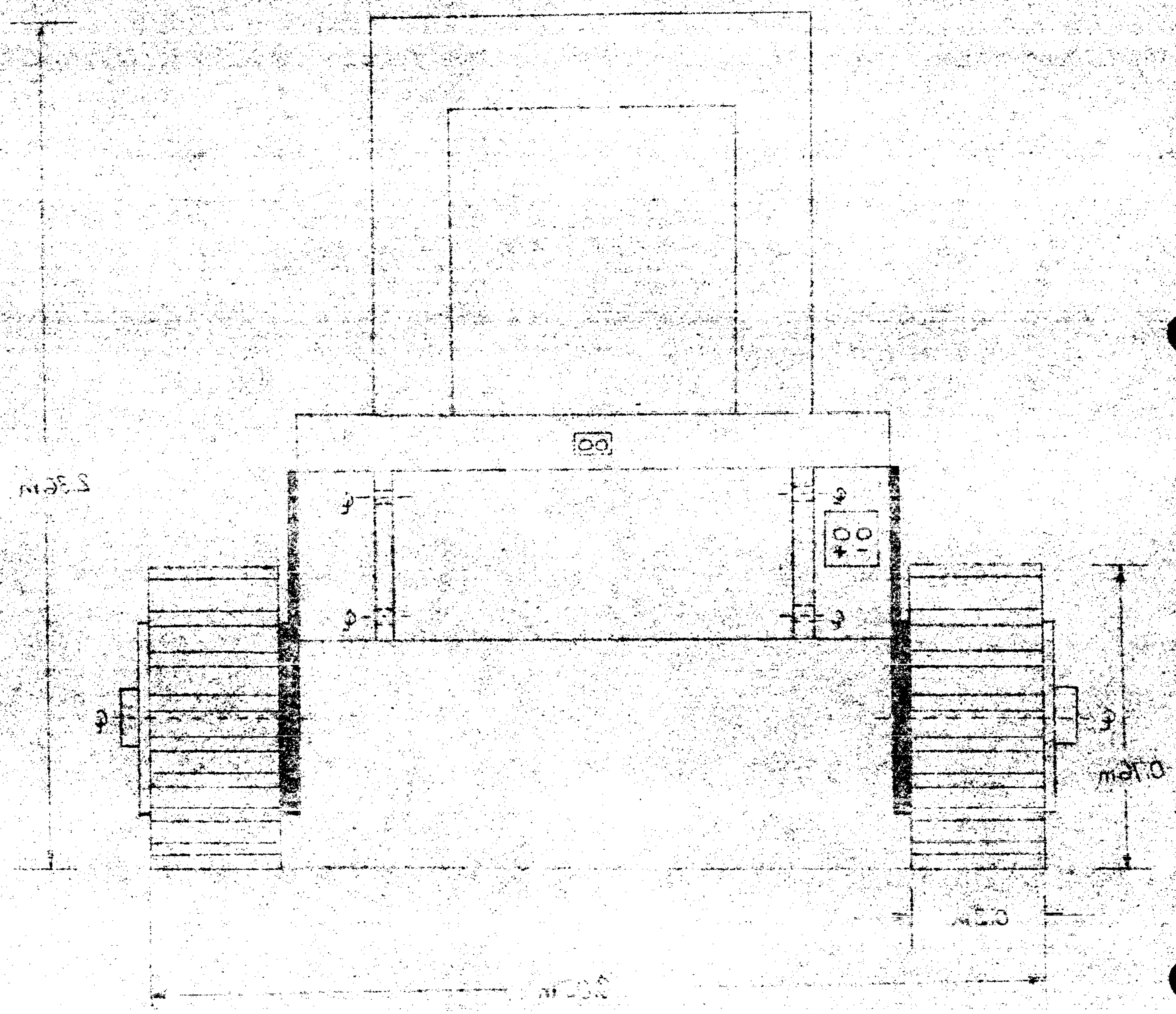


LUNAR DOZER
REAR VIEW
2-25-85 DEW



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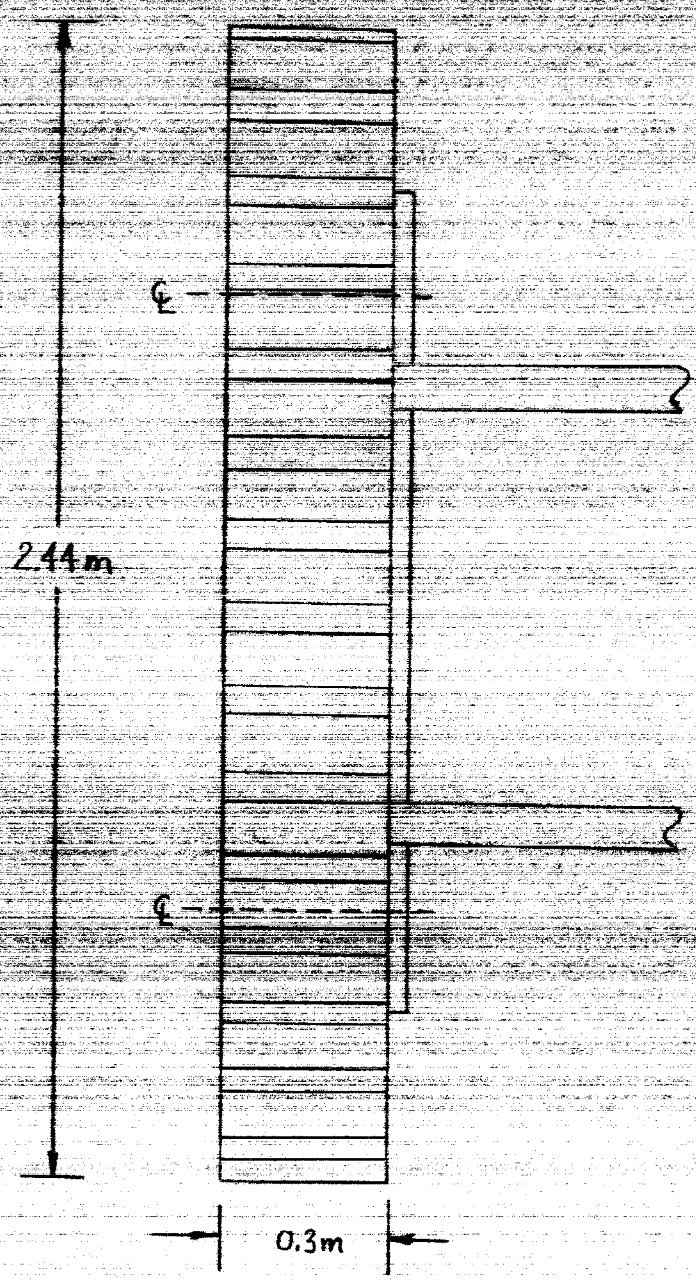
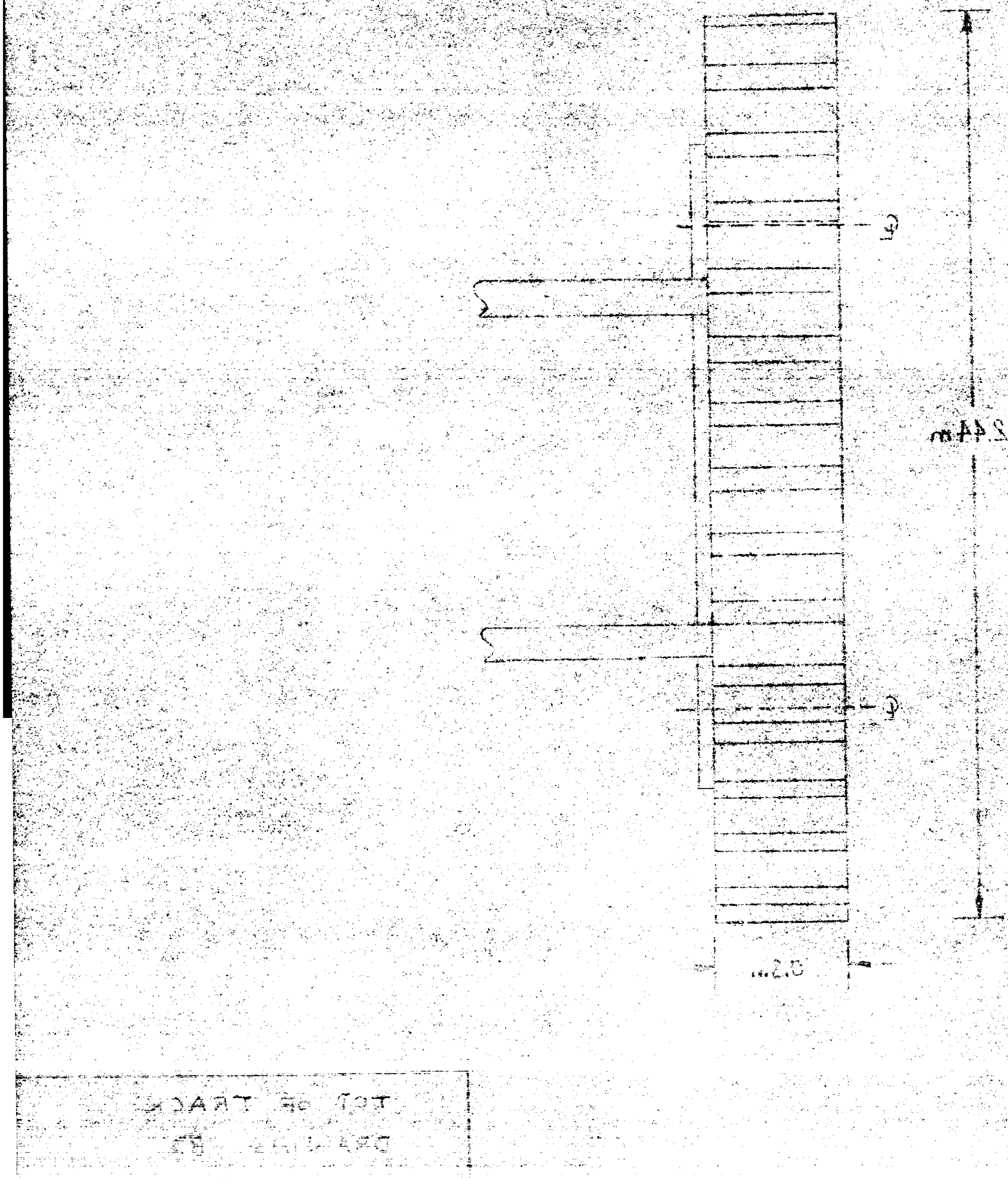
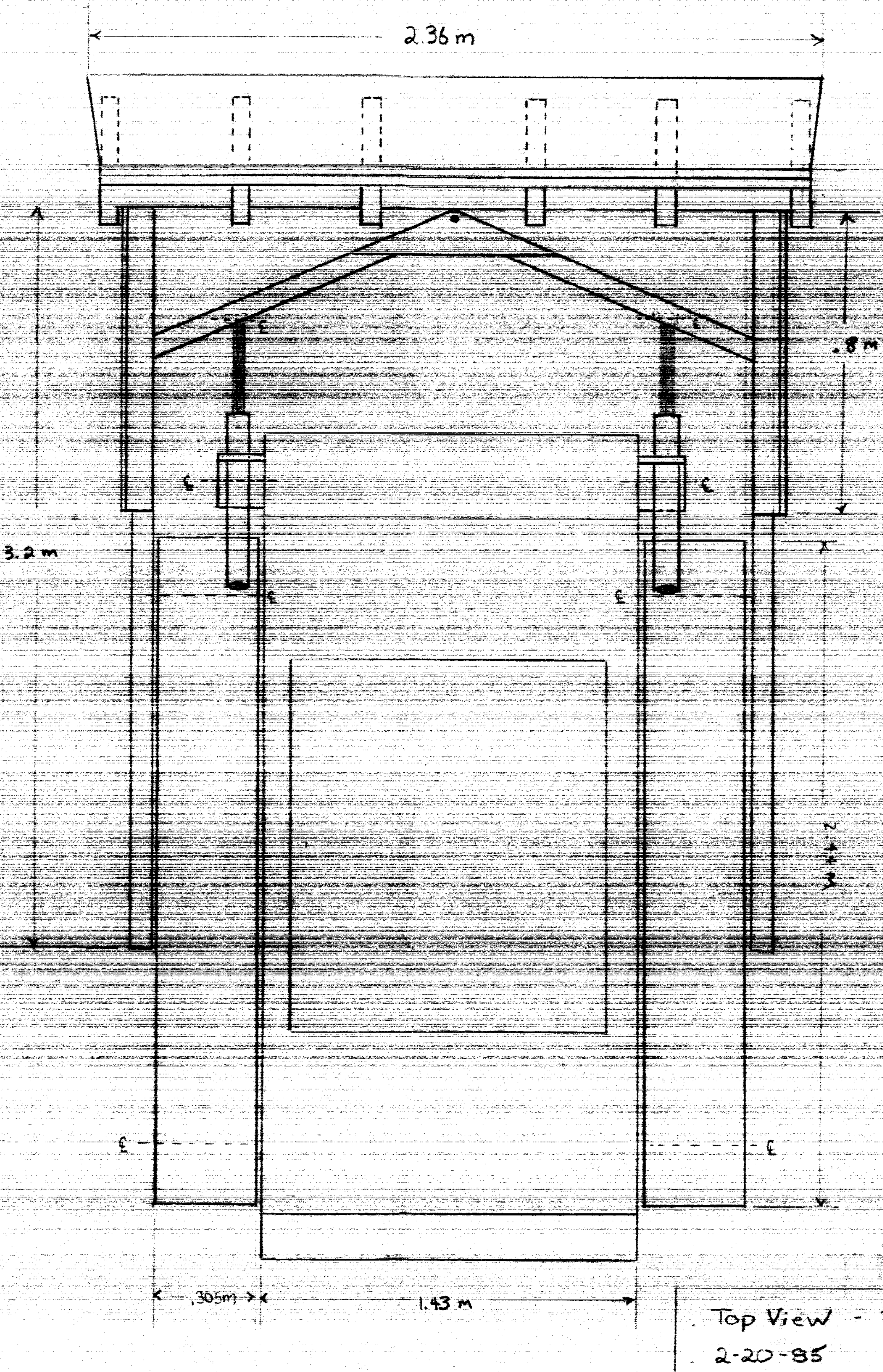
REAR VIEW



TOP OF TRACK
DRAWING B2
2-28-85 DEW

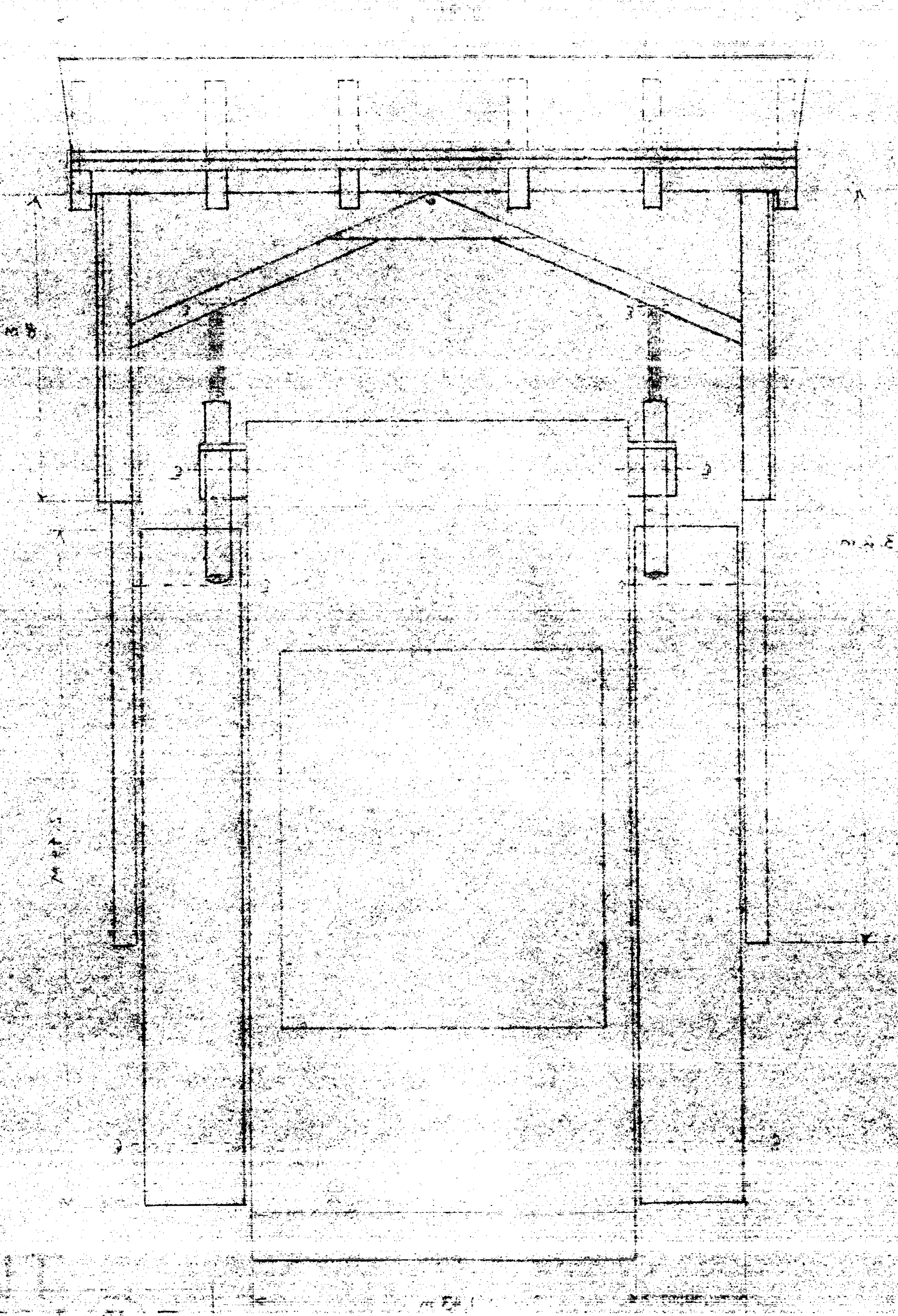


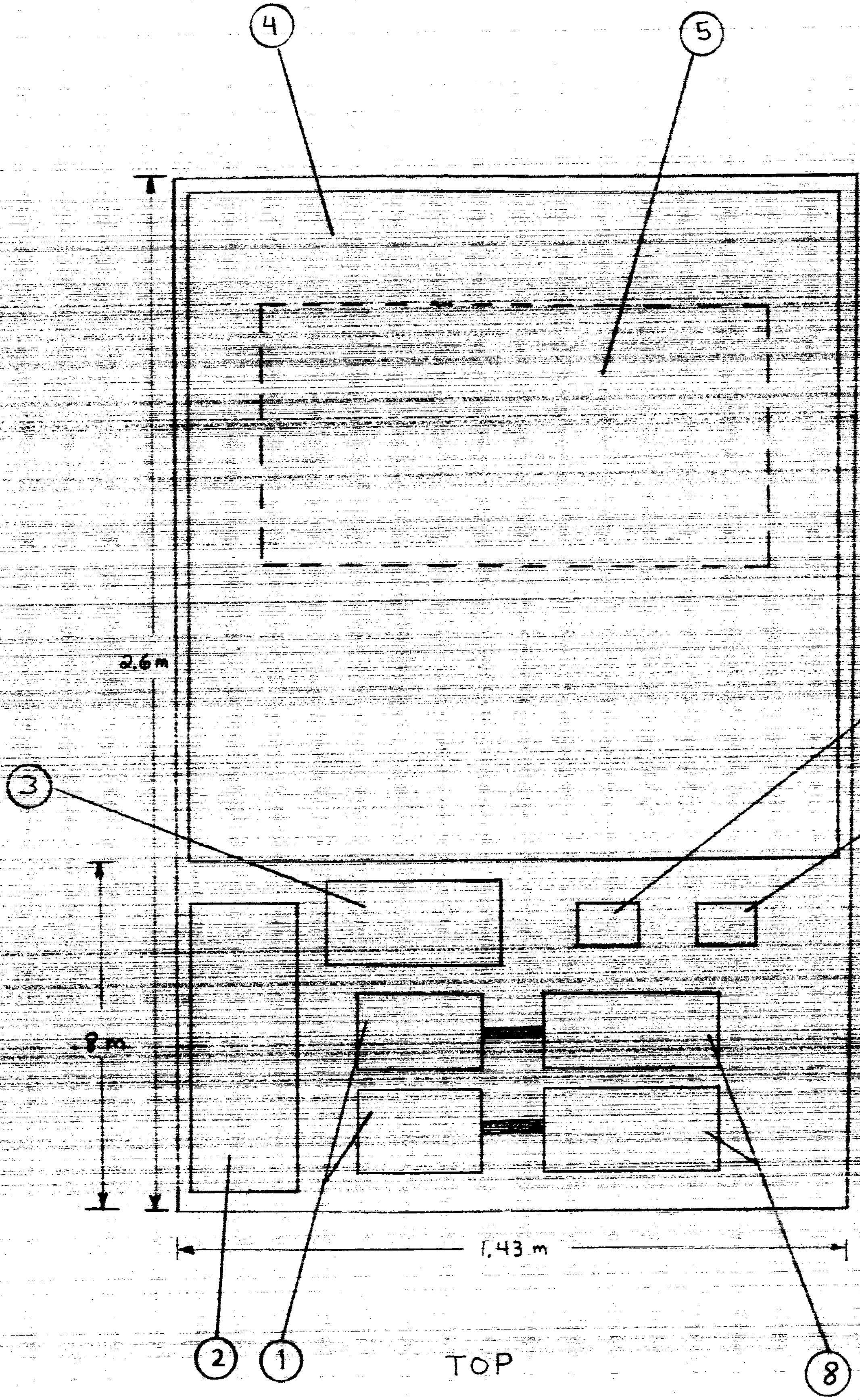
2.44m
0.5m
TRACK



Top View - Dozer

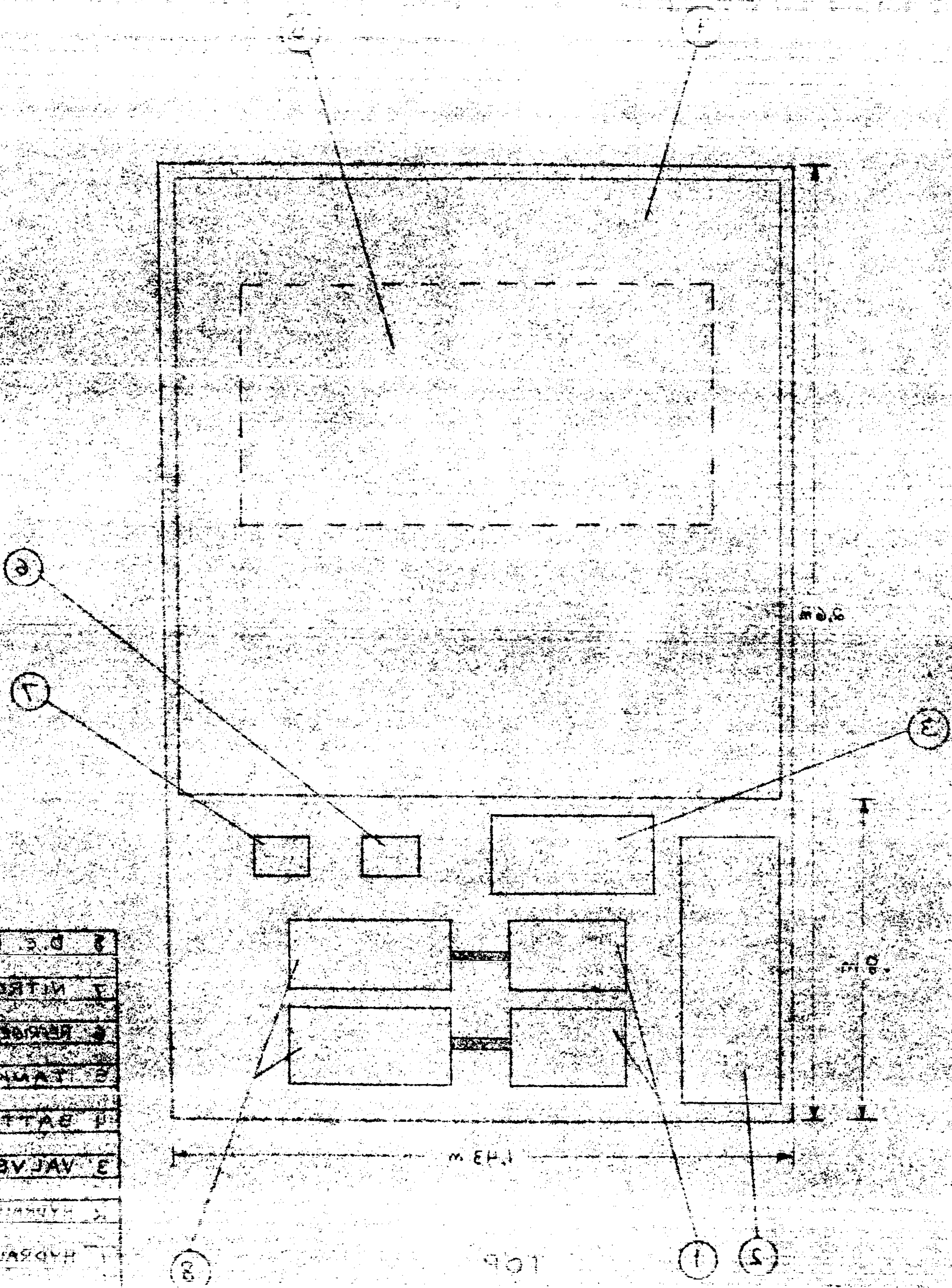
2-20-85 RWF





8	D.C. MOTOR
7	NITROGEN PUMP
6	REFRIGERANT PUMP
5	TANK
4	BATTERIES
3	VALVE BODY
2	HYDRAULIC TANK
1	HYDRAULIC PUMP

DRAWING : C-C
INTERNAL LAYOUT
3-5-85 T.N.A.



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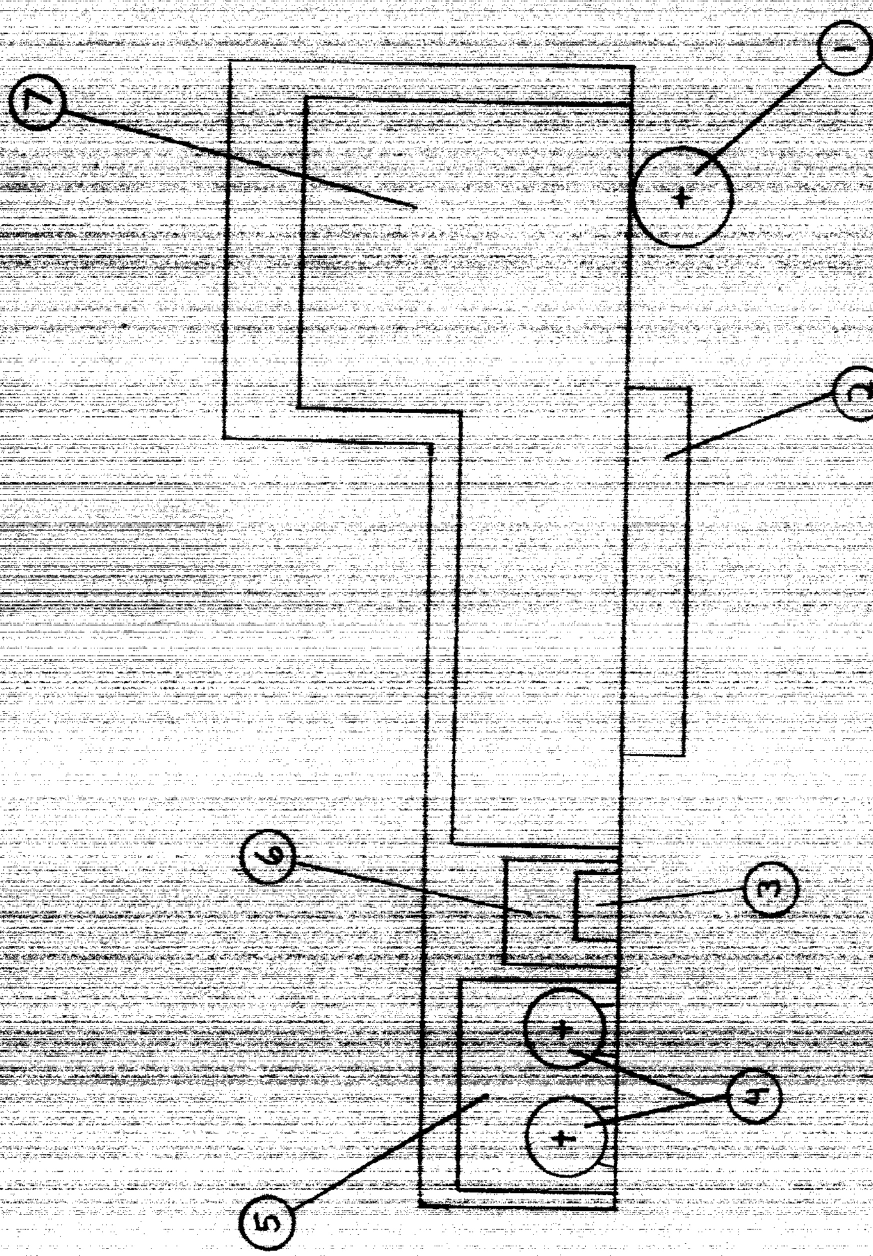
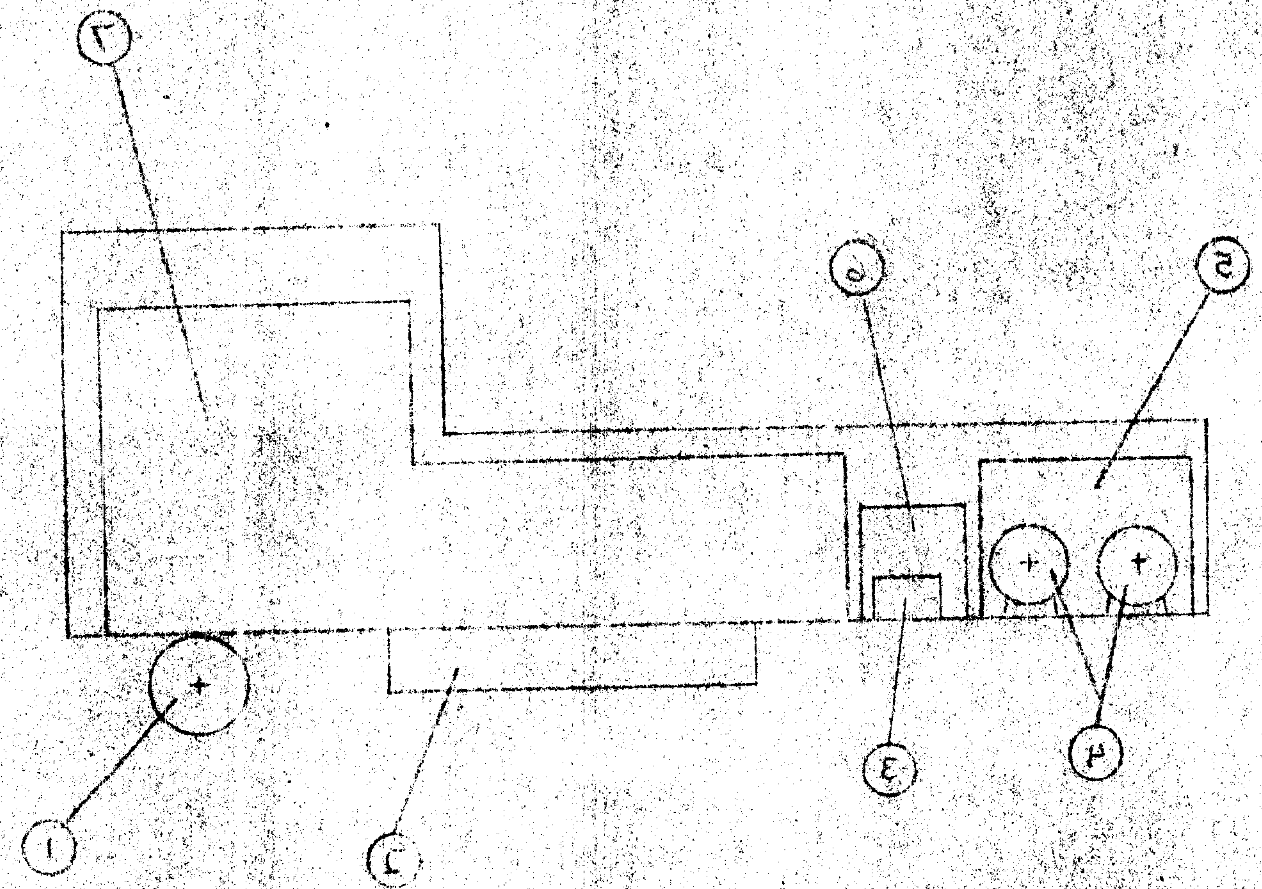
4	BATTERIES
3	VALVE BODY
2	HYDRAULIC TANK
1	HYDRAULIC PUMP

DRAWING [illegible] C-C
INTERNAL LAYOUT

1 - HYD. MOTOR
2 - COOLANT TANK
3 - COOLANT PUMP
4 - D.C. MOTORS
5 - HYD. RESERVOIR
6 - VALVES
7 - BATTERIES

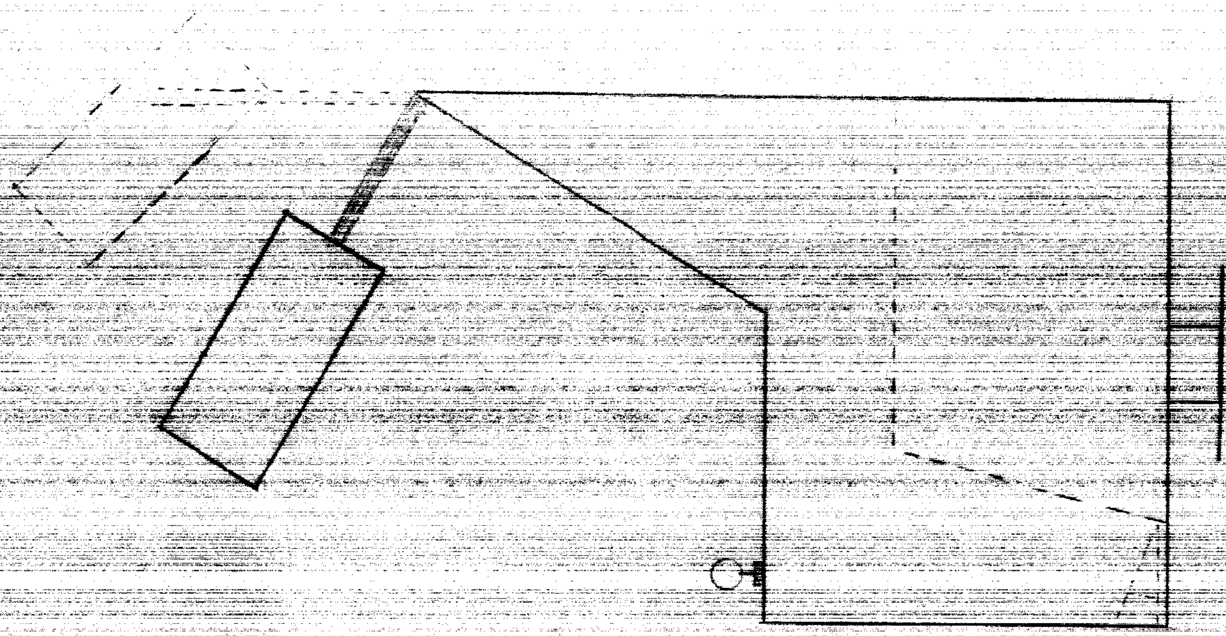


INTERNAL LAYOUT
SIDE VIEW E-E
3-6-85 TNA

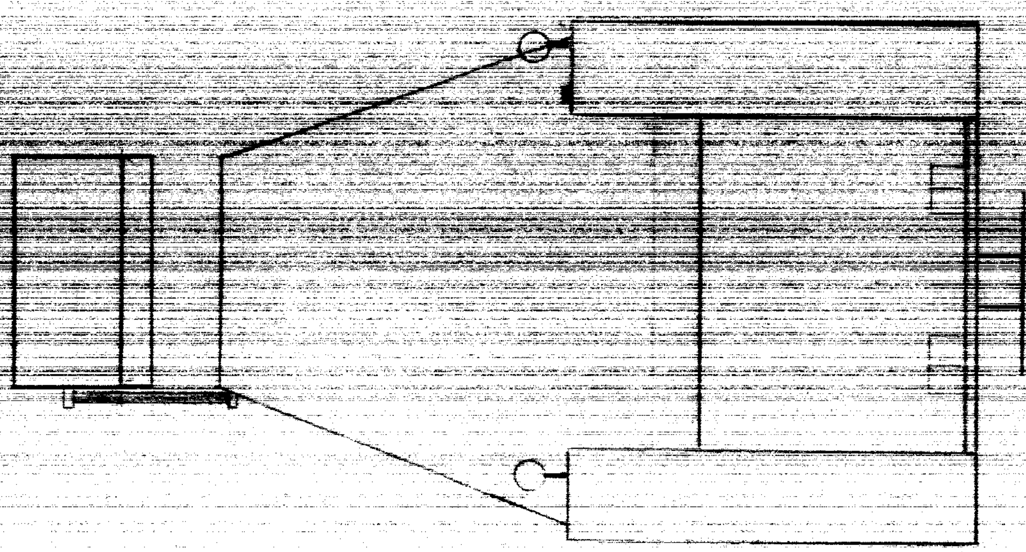


1 HTG MOTOR
2 COOLANT TANK
3 COOLANT TUBES
4 D.C. MOTORS
5 BATTERY BOXES
6 VALVE
7 BATTERIES

SIDE VIEW E-E



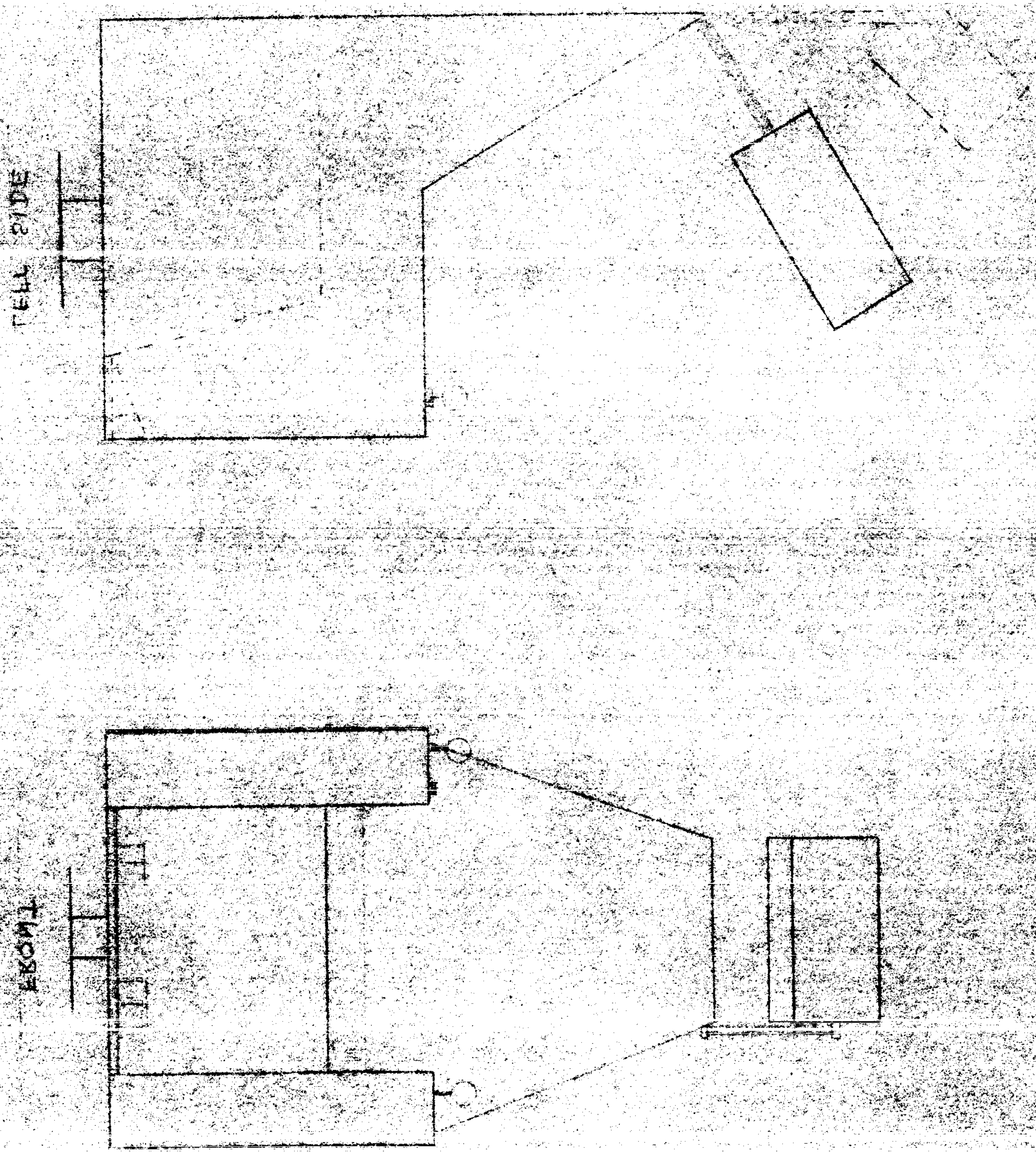
LEFT SIDE



FRONT

CAPTAIN'S CHAIR

2-27-85 RWF



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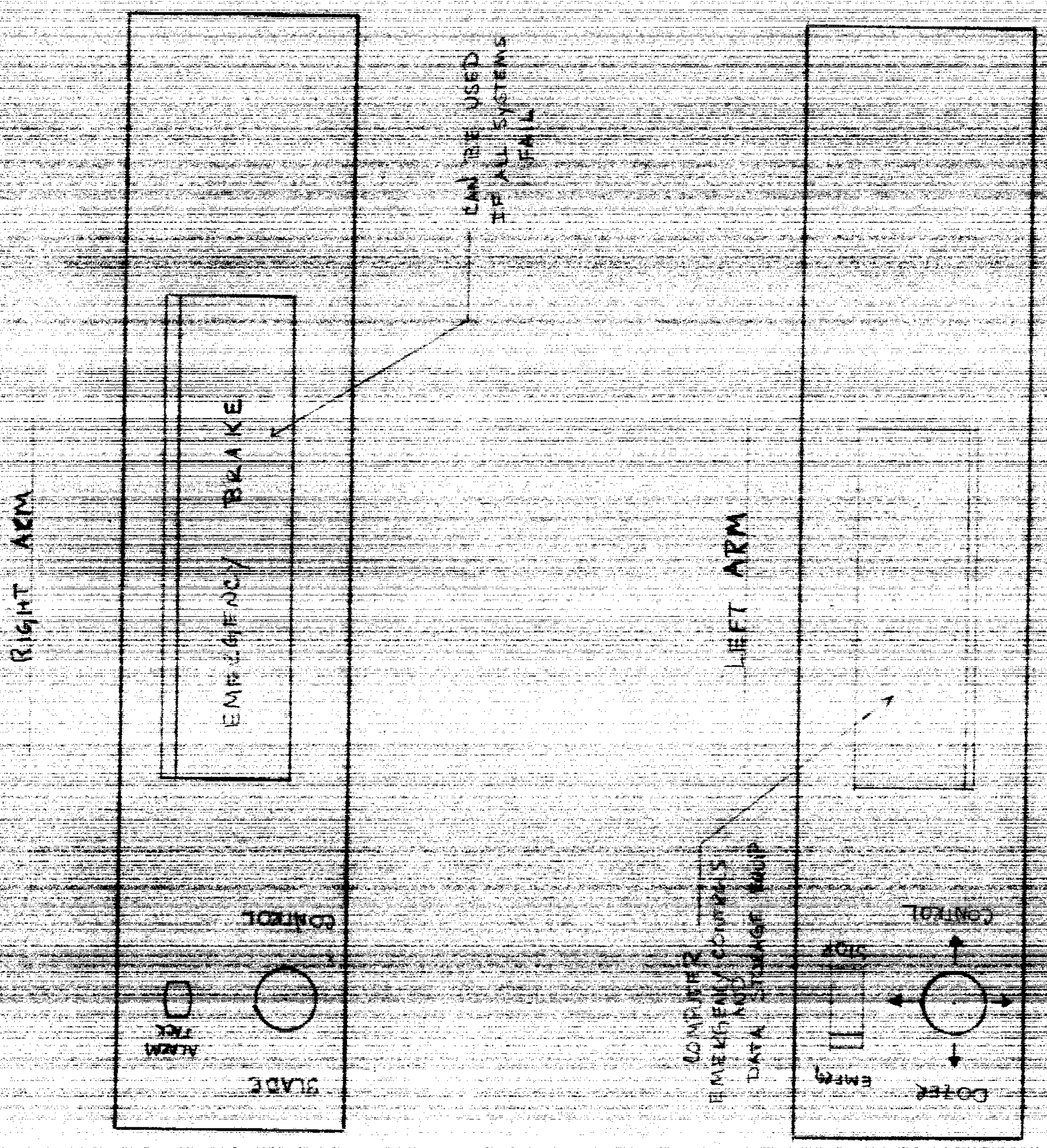

ARM CONTROLS

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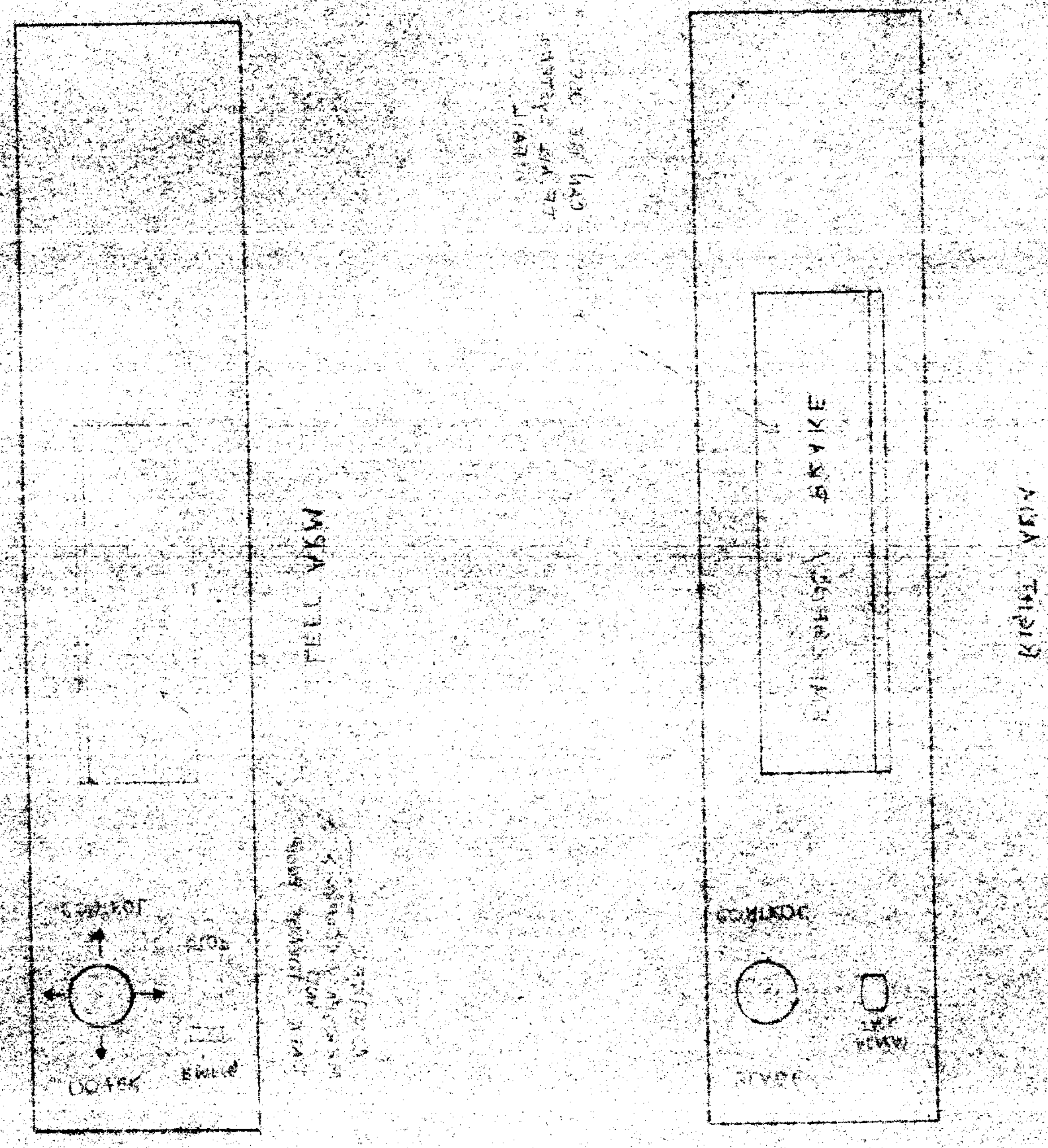

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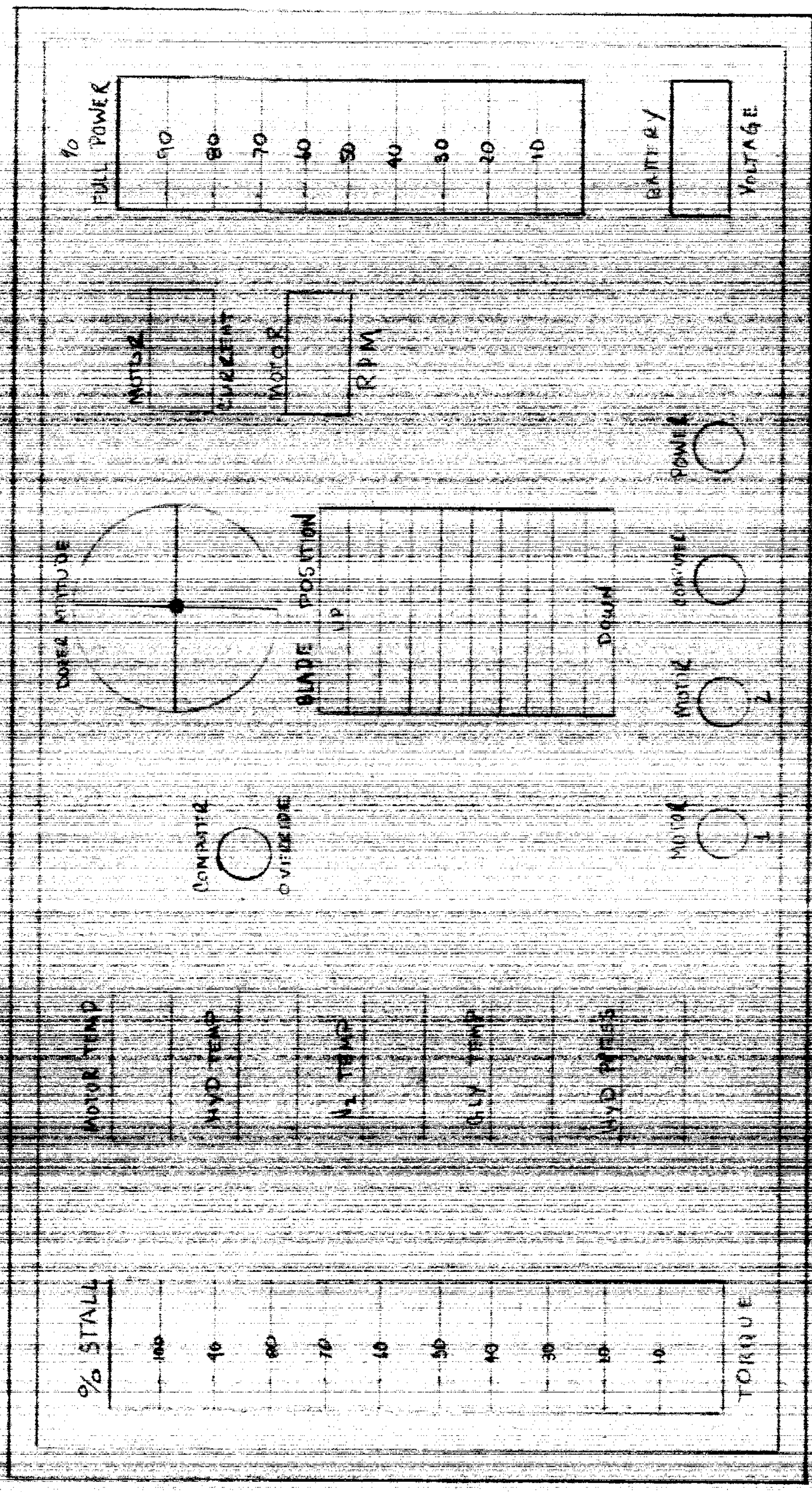

INSTRUMENT
PANEL
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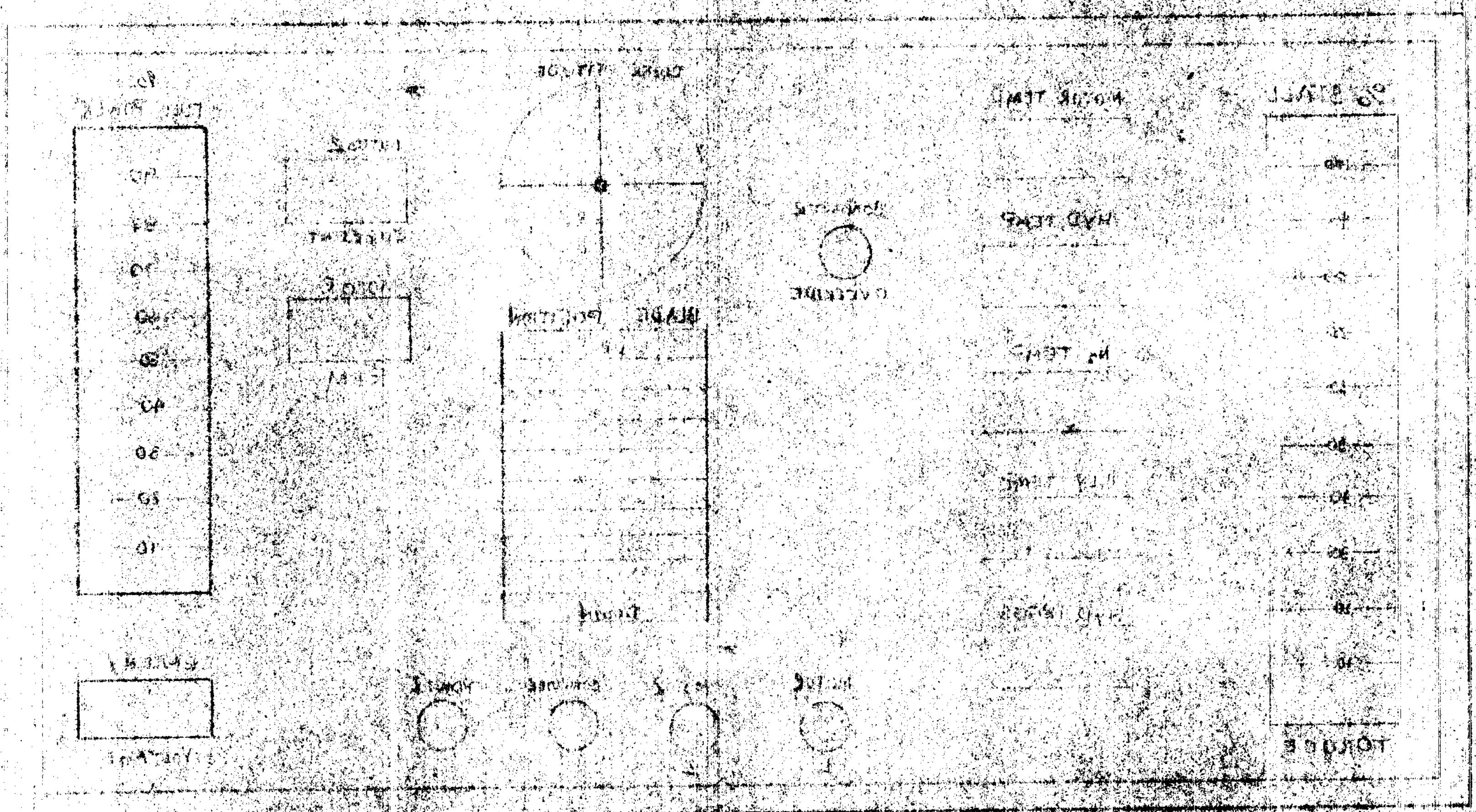
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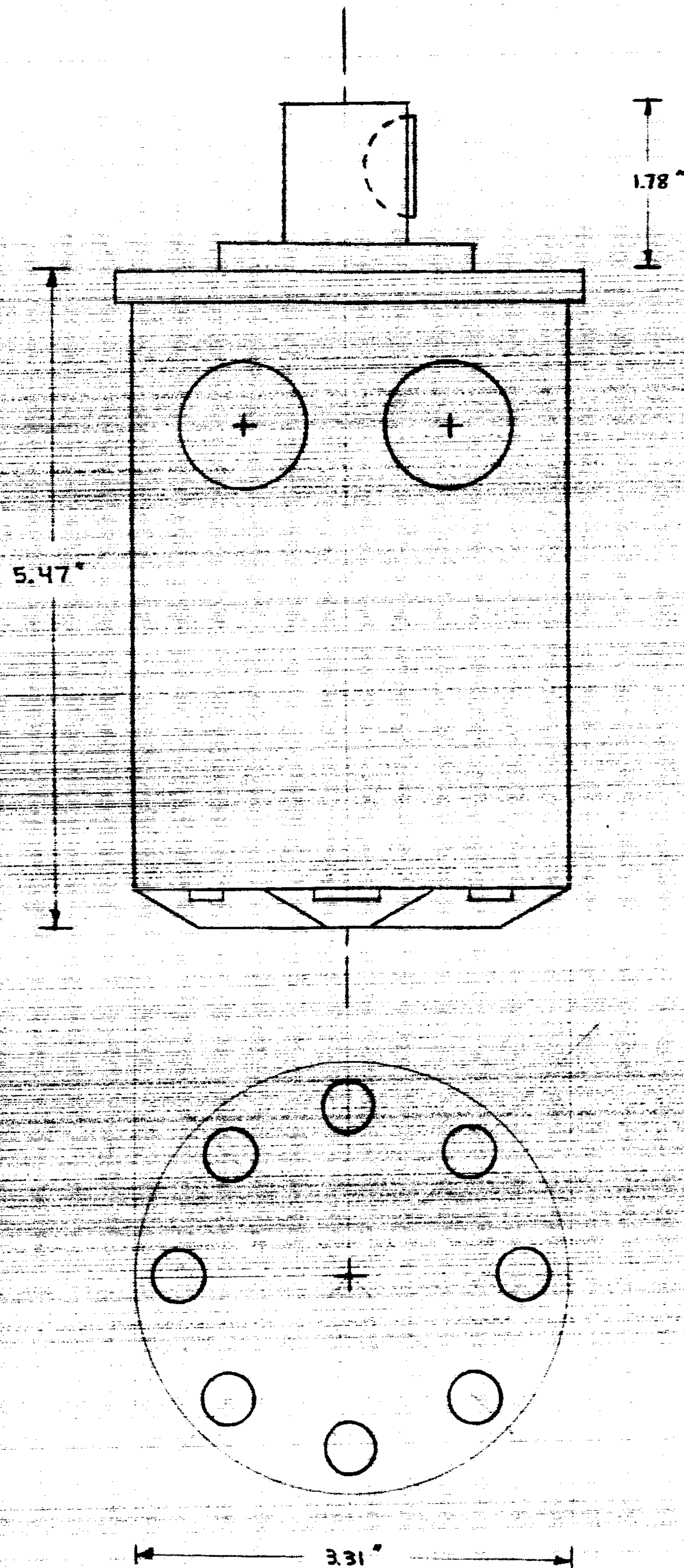
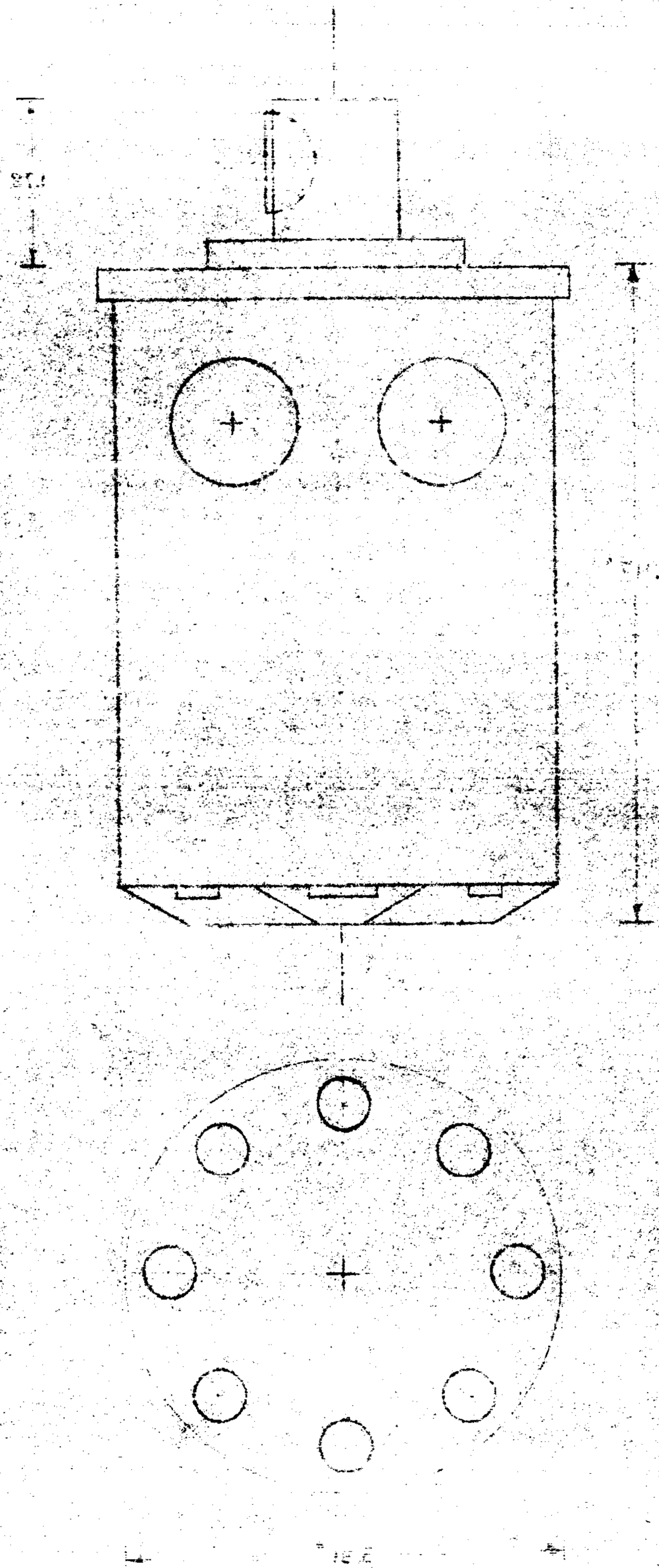
HYD TEMP

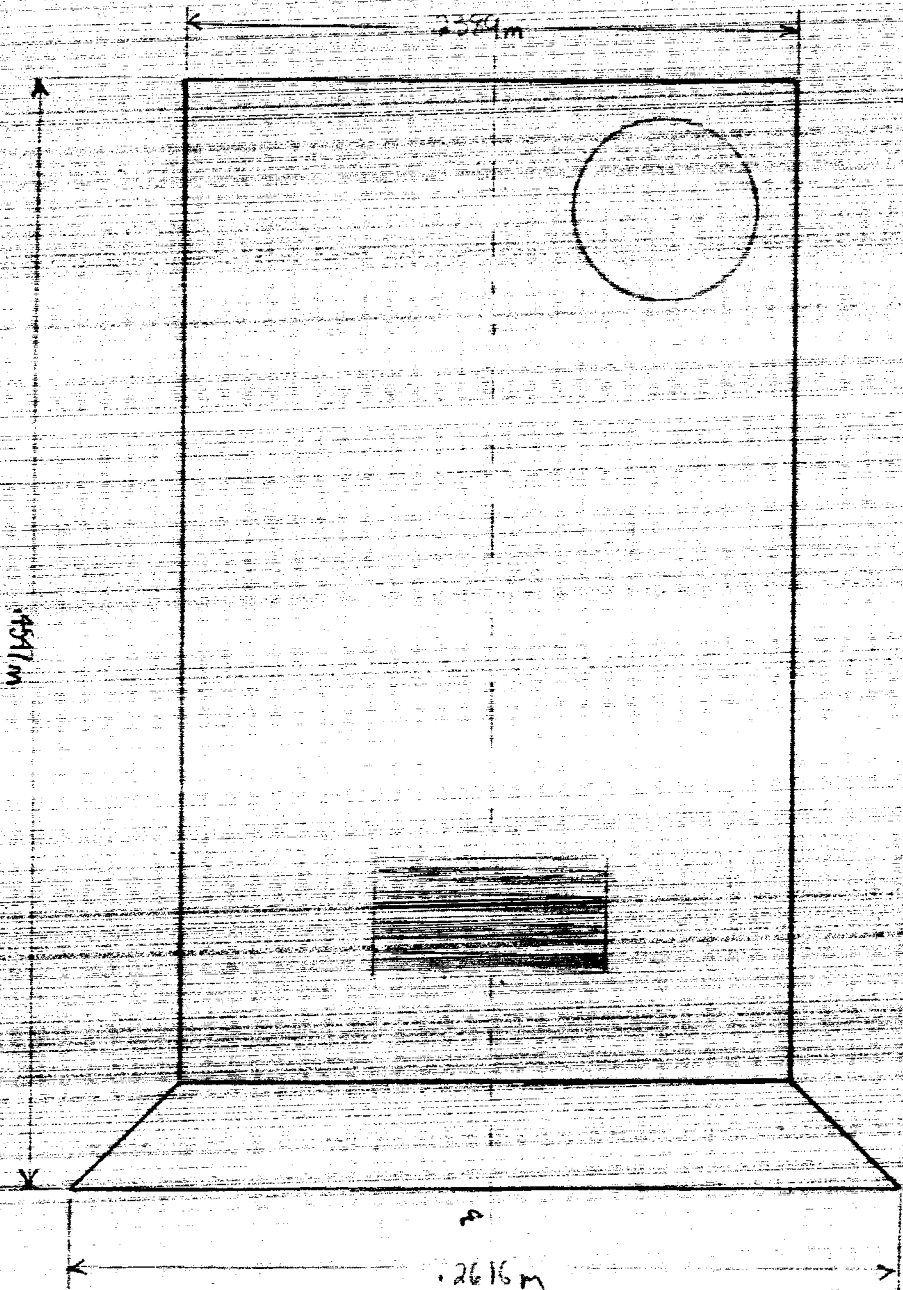


HYDRAULIC MOTOR

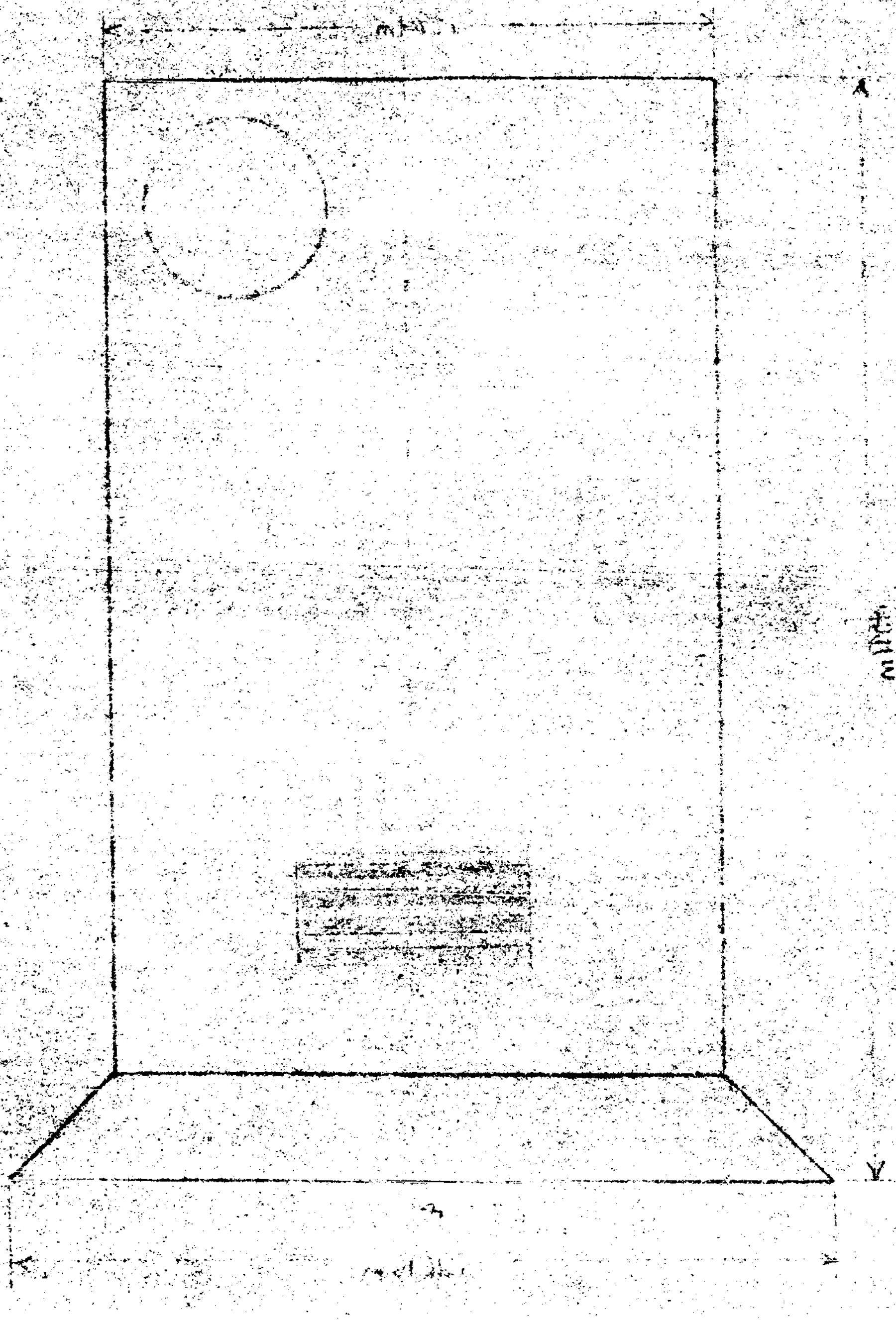
DRAWING : C1

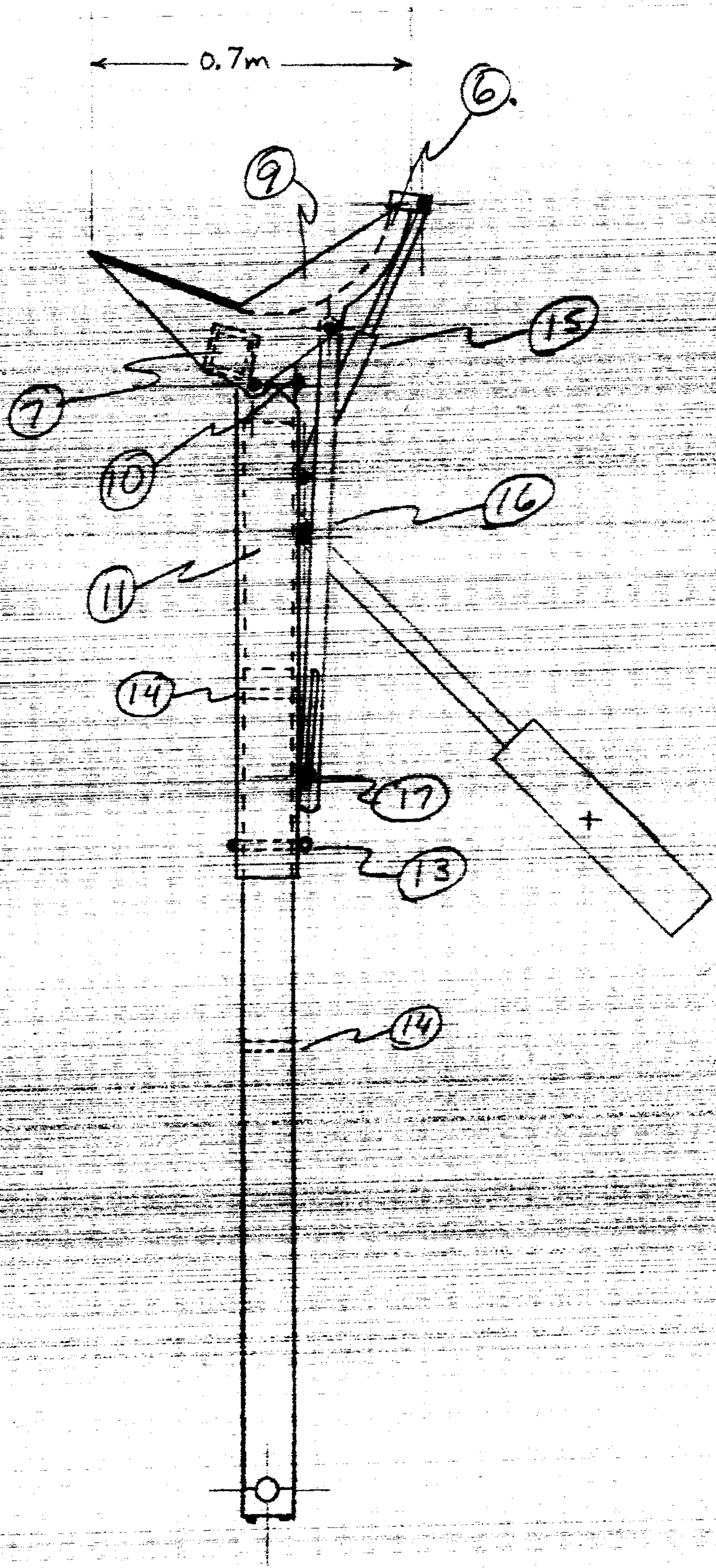


HYDRAULIC MOTOR

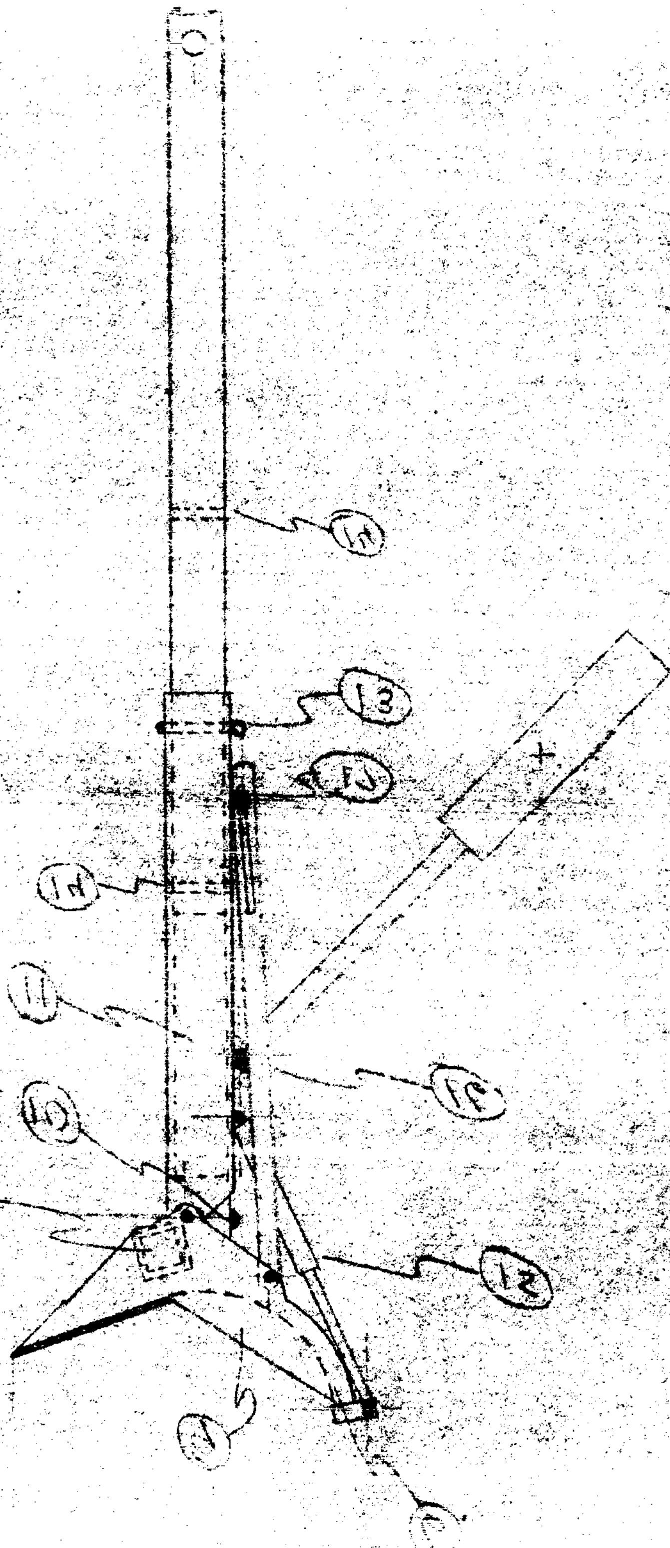


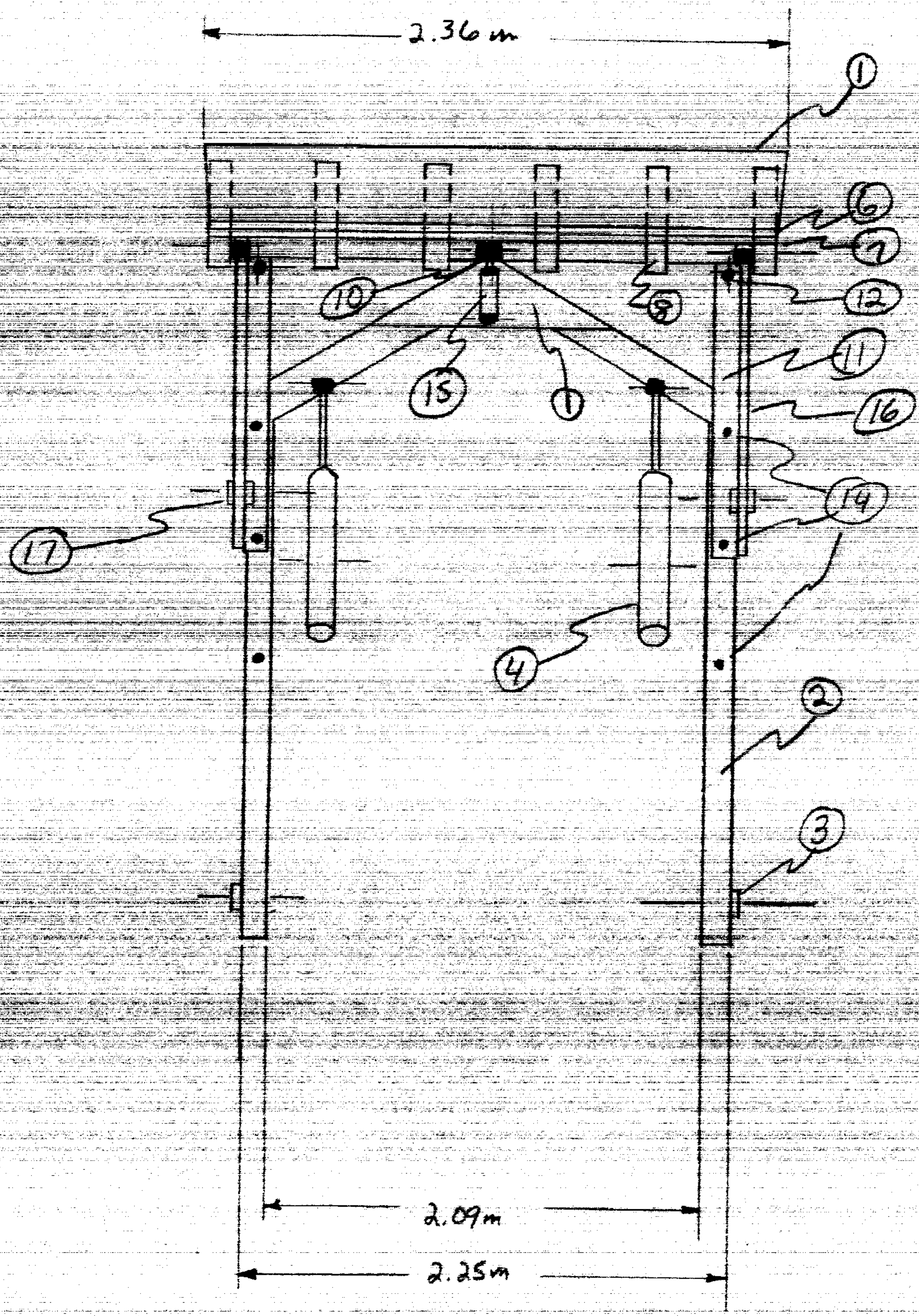
GE 20 HP ~~Motor~~
SERIES WOUND
RWF 3-4-85





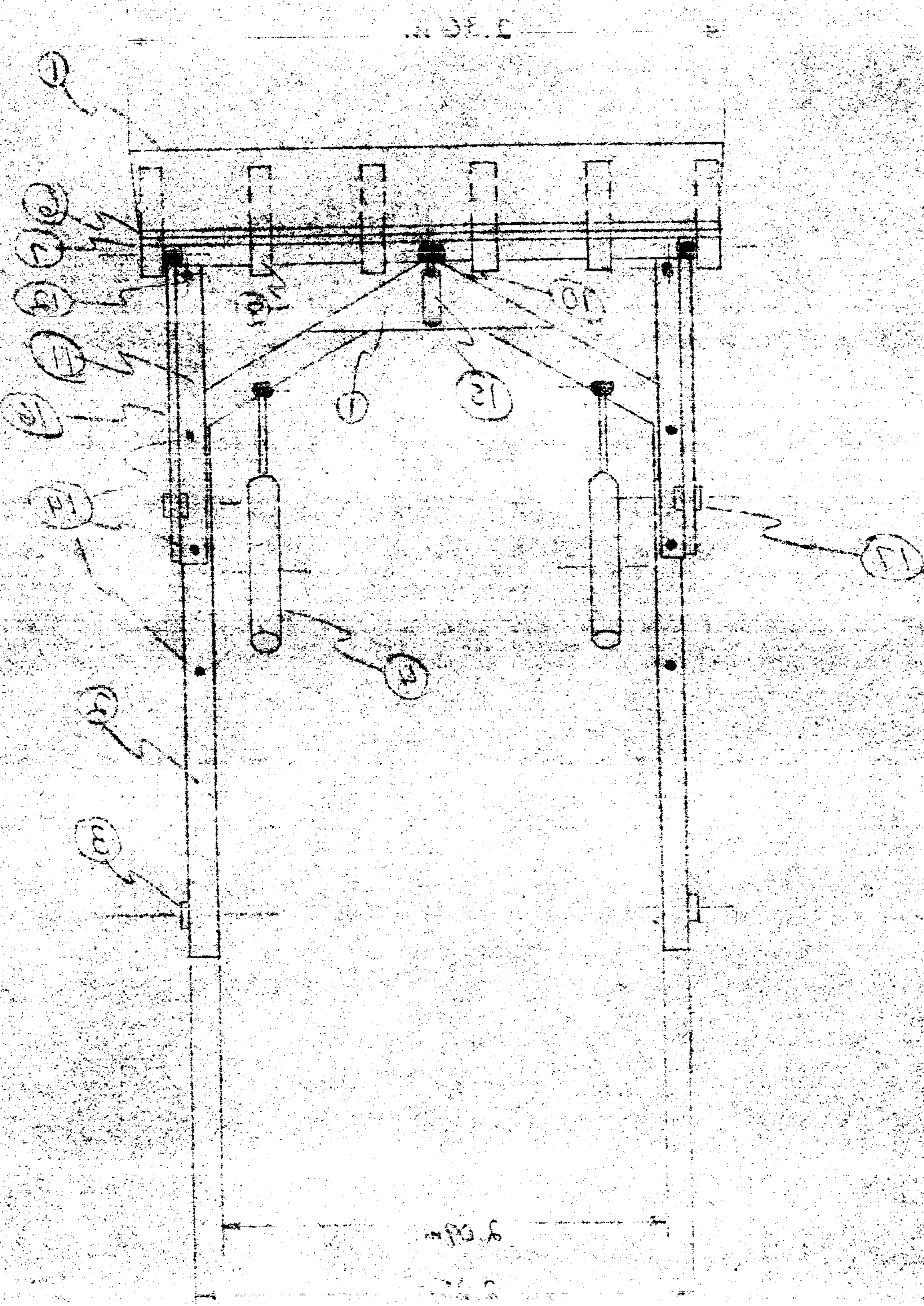
VIEW D-D
Dozer Blade & C-frame
Side View NTS



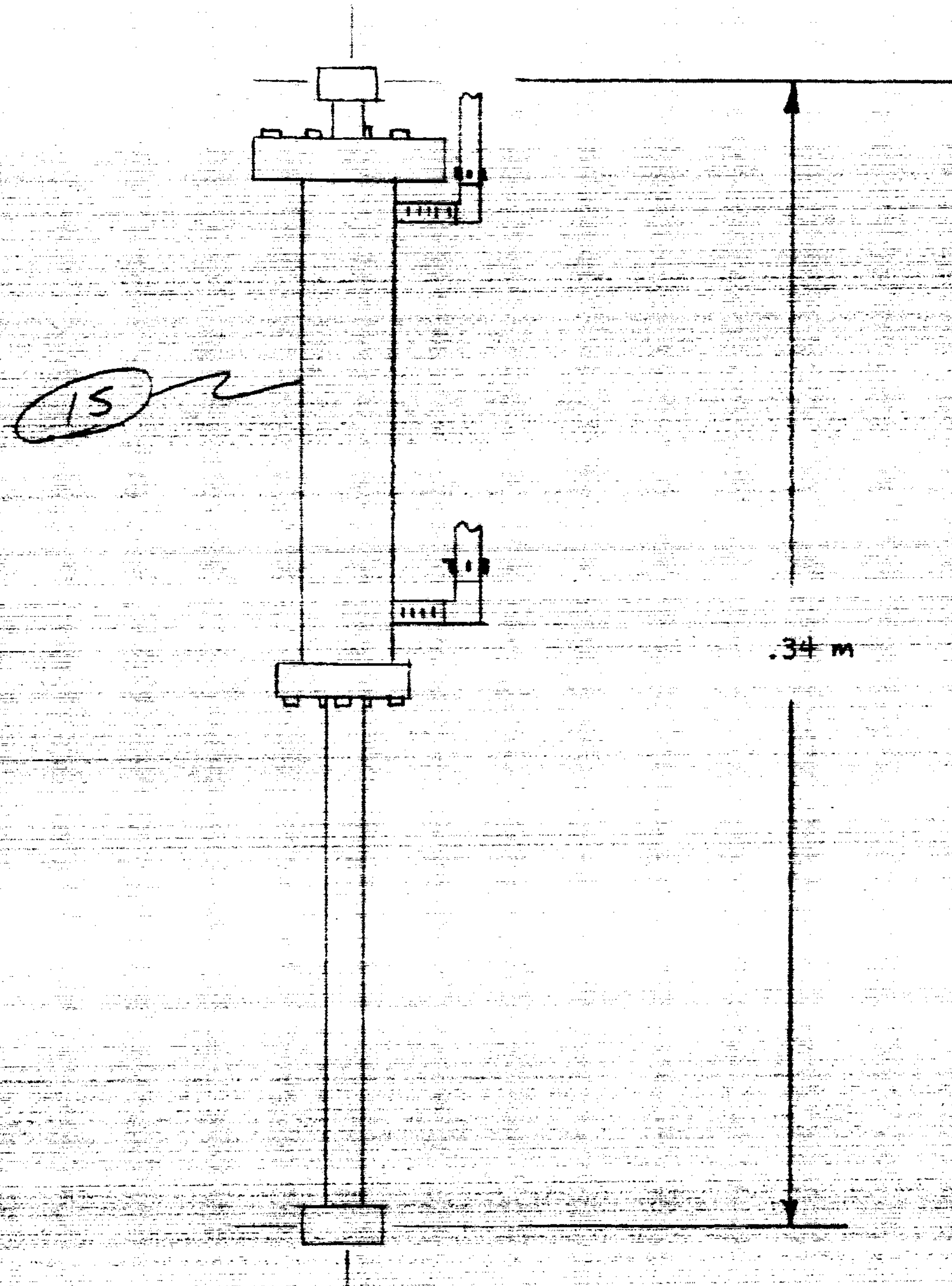


DRAWING A1

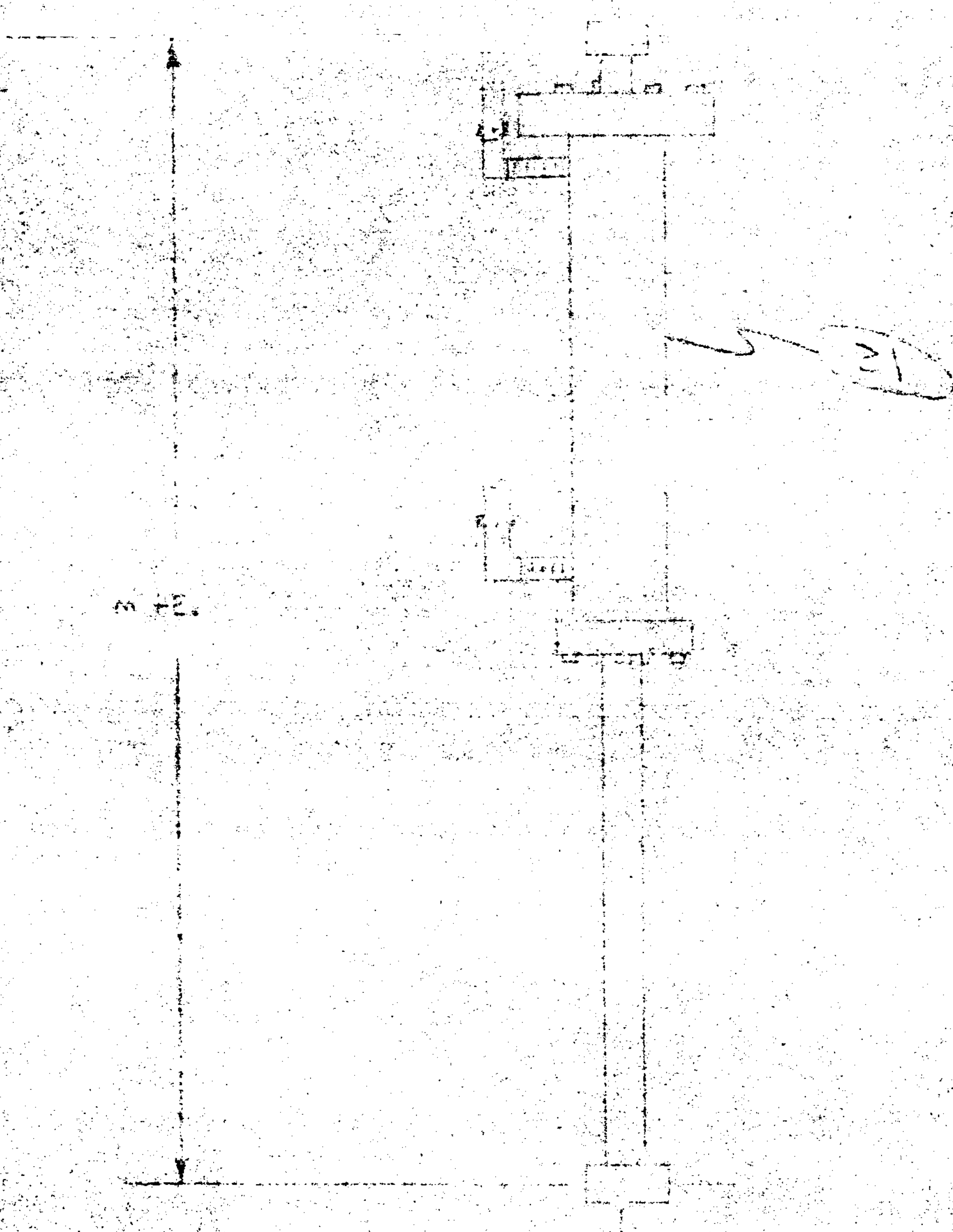
TOP VIEW OF ~~BLADE~~

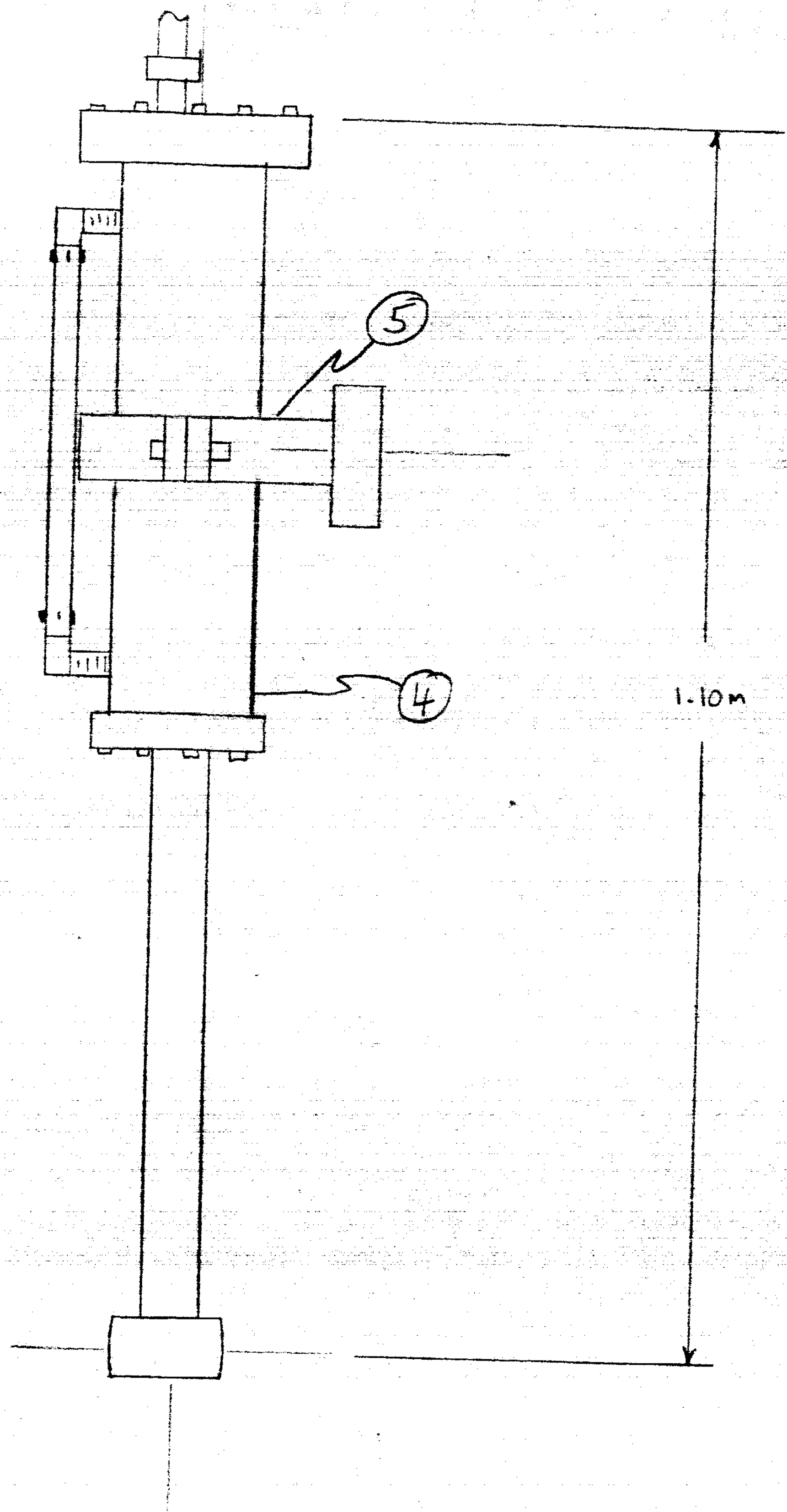


DRAWING A



HYDRAULIC
CYLINDER 2





HYDRAULIC CYLINDER

DRAWING A3.[illegible]

SUBSYSTEM: BLADE

ITEM#	QTY	DESCRIPTION	VENDOR	COST
1	1	BLADE CENTER BRACKET		
2	2	ARM		
3	2	PIN		
4	2	HYDRAULIC CYLINDER		
5	2	SUPPORT BRACKET		
6	1	BLADE		
7	1	BLADE PIVOT		
8	6	BLADE SUPPORTS		
9	2	SIDE SHIELD		
10	1	PIN		
11	2	BLADE ARM		
12	2	PIN		
13	2	CLAMP		
14	6	ADJUSTMENT PINS		
15	1	HYDRAULIC CYLINDER		
16	2	PIVOT ROD		
17	2	PIN		

APPENDIX

ME 4182 WEEKLY PROGRESS REPORT

PERIOD: Jan 10 THRU: Jan 24, 1985 TEAM NO.: TH-3:00

TITLE: Lunar Surface Site Preparation Apparatus

COMMENTS: Everybody in the group researched the lunar environment or dozers during the first week. We then met to discuss our findings. After discussing what we had learned about the lunar environment and dozers, we made a list of constraints and specifications for our problem statement. We then split up further research so that a particular person would search under a specific topic.

NAME, INITIALS	HOURS ENGINEERING	TECHNICIAN	CLERICAL	TOTAL
1) Ayers, T.	4			4
2) Wardall, D.	4			4
3) Faglier, R.	5			5
4) Crane, M.	5			5
5) Coppedge, S.	4		1.5	5.5
6)				
TOTALS =	22		1.5	23.5

ME 4182 WEEKLY PROGRESS REPORT

PERIOD: TU-3 THRU: 1/31/85 TEAM NO.: TH-3:00

TITLE: Lunar Surface Site Preparation Apparatus, DOZER

COMMENTS:

The past week was used mainly for information searching and research. Several hours ~~was~~ were spent observing real bulldozers in action. Also, a productive group meeting was held in which all the options for power, traction, and other variables were discussed and decisions made. More research was done in the areas of soil mechanics and patent searching.

	NAME, INITIALS	HOURS			
		ENGINEERING	TECHNICIAN	CLERICAL	TOTAL
1)	AYERS, T.	4.0		1.0	5.0
2)	WARDALL, D.	3.5			3.5
3)	FAGLIER, R.	5.5			5.5
4)	CRANE, M.	4.0			4.0
5)	COPPEDGE, S.	4.0			4.0
6)					
	TOTALS =	21.0		1.0	22.0

ME 4182 WEEKLY PROGRESS REPORT

PERIOD: 1-31-85 THRU: 2-7-85 TEAM NO.: TH - 3:00

TITLE: Lunar Site Preparation Apparatus

COMMENTS:

Last week was very productive. We had a long group meeting, in which we examined the possibility of not completing the project on schedule. We concluded that it was not only possible, but no new technology would be required. The Dozer design was then broken into components and the design and development of the components commenced. As of now we have tentatively tied the tracks down to a Hydraulic drive type with the drive built on to the tracks, but some design changes will be required.

		HOURS			
	NAME, INITIALS	ENGINEERING	TECHNICIAN	CLERICAL	TOTAL
1)	T. Ayers	5		1	6
2)	S. Coppedge	5			5
3)	M. Crane	4			4
4)	R. Faglier	5		1	6
5)	D. Wardall	5			5
6)					
	TOTALS =	24		2	26

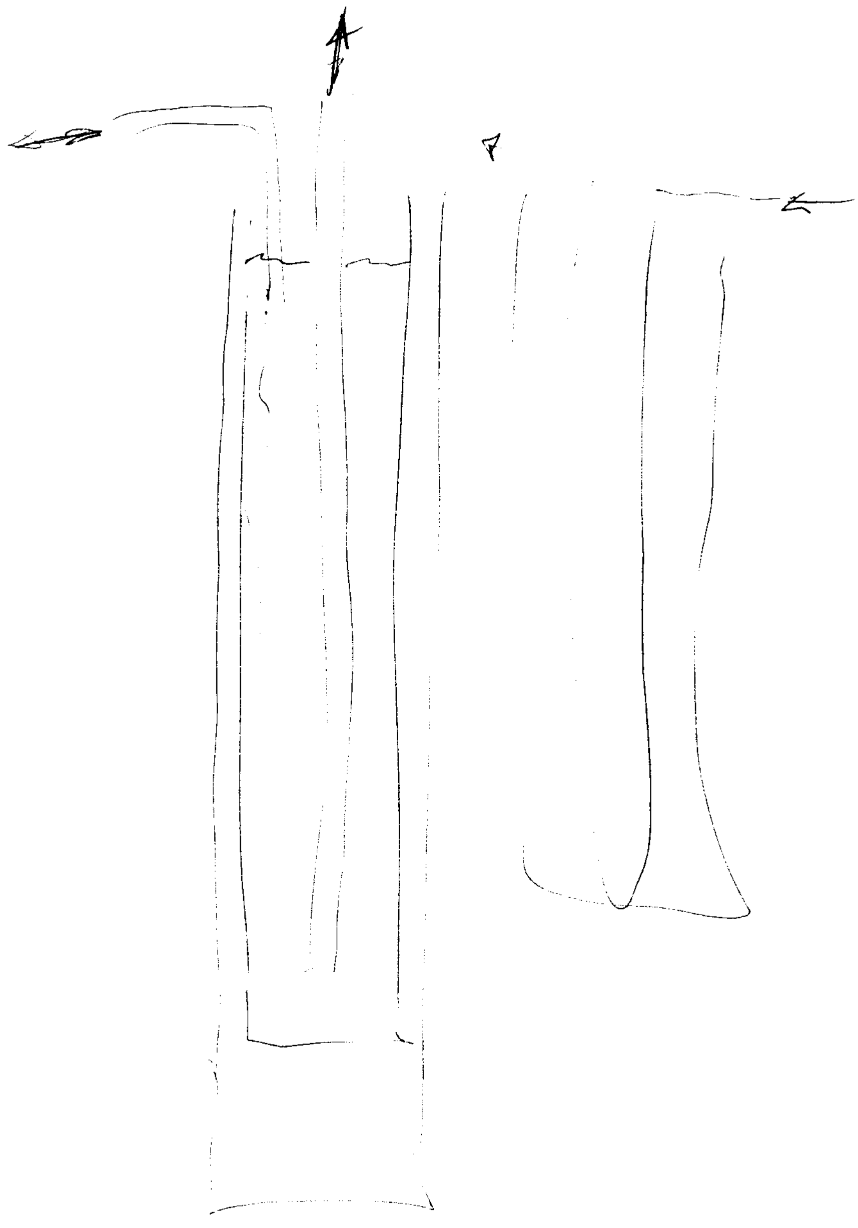
ME 4182 WEEKLY PROGRESS REPORT

PERIOD: Feb 7 THRU: Feb 14, 1985 TEAM NO.: Th-3:00

TITLE: Lunar Site Preparation Apparatus

COMMENTS: This week the group solidified our design by making some fundamental force and friction calculations to see if the design should work. The blade has been mostly specified. It will be much like a front loader. Crude calculations were made for necessary torque to run the hydraulic pumps.

NAME, INITIALS	HOURS ENGINEERING	TECHNICIAN	CLERICAL	TOTAL
1) Coppedge, S.	5			5
2) Crane, M.	6			6
3) Faglier, R.	5			5
4) Ayers, T.	6			6
5) Wardall, D.	5			5
6)				
TOTALS =	27			27



ME 4182 WEEKLY PROGRESS REPORT

PERIOD: Feb. 14 THRU: Feb. 21 TEAM NO.: TH 3:00

TITLE: Lunar Surface Site Preparation Apparatus

COMMENTS:

Last week the decision was made to use 2 DC motors to power the Hydraulic pumps. The suggestion was made to use a Heads-up method of display for critical information. The discussion of control systems for both information and operation was continued. The initial work on the drawings was started.

NAME, INITIALS	HOURS ENGINEERING	TECHNICIAN	CLERICAL	TOTAL
1) T. Ayers	4			4
2) M. Crane	4			4
3) S. Coppedge	4			4
4) R. Faglier	4		0.5	4.5
5) D. Wardall	4			4
6)				
TOTALS =	20		0.5	20.5

ME 4182 WEEKLY PROGRESS REPORT

PERIOD: 8 THRU: 2/28 TEAM NO.: TH-3:00

TITLE: Lunar Surface Site Preparation Bulldozer

COMMENTS:

The group had a meeting on Sunday in which the plan for the rest of the quarter was discussed. The report outline was reviewed to clarify the remaining tasks. Sketches of the dozer were complied so that detailed drawings could be produced. Each person worked on their drawings and also worked to compile references.

NAME, INITIALS	HOURS ENGINEERING	TECHNICIAN	CLERICAL	TOTAL
1) WARDALL, D.	5.0			5.0
2) COPPEDGE, S.	6.5			6.5
3) CRANE. M.	4.0			4.0
4) FAGLIER, R.	5.5			5.5
5) AYERS, T.	6.0			6.0
6)				
TOTALS =	27.0			27.0

M. E. 4182
Project Progress Report

From: 2-28 Thur: 3-7 Sect. ; TH 3:00

Title: Lunar Surface Site Preparation Apparatus

Comments:

A portion of the week was spent working on drawings. But a majority of the time was spent on the rough draft. The ~~surch~~ SEARCH for a set of batteries was completed. Additional work was done in the area of system controls.

NAME	Engineering	Total
1) T. Ayers	10	10
2) S. Coppedge	9	9
3) M. Crane	9	9
4) R. Faglier	10	10
5) D. Wardall	9.5	9.5
		47.5

RECORD OF INVENTION - Part I

This is an important legal document. Read instructions carefully before filling in data.

PROJECT NO.

RECOMMENDED SECURITY CLASSIFICATION

REC. OF INV. NO.

CONTRACT NO.

1. NAME OF INVENTOR: M.E. 4182 GROUP — POSITION: STUDENT

2. DEPARTMENT OR DIVISION: GEORGIA INSTITUTE OF TECHNOLOGY

3. DATES OF EMPLOYMENT

4. PRESENT ADDRESS (No. Street, City, County, State): GEORGIA TECH BX 30526 ATLANTA, GA — TELEPHONE — PERMANENT OR UNTIL

5. PERMANENT ADDRESS (No. Street, City, County, State) — TELEPHONE

6. NAMES (S) AND ADDRESS (ES) OF CO-INVENTORS (If any)

7. DESCRIPTIVE TITLE OF INVENTION: LUNAR SURFACE SITE PREPARATION APPARATUS

8. LIST DRAWINGS, SKETCHES, PHOTOS, REPORTS, DESCRIPTIONS, NOTEBOOK ENTRIES, ETC. WHICH SHOW OR DESCRIBE INVENTION

A-A A1, A2, A3
B-B B1, B2, B3 } DRAWINGS PLUS TECHNICAL REPORT
C-C C1, C2, C3

9. EARLIEST DATE AND PLACE INVENTION WAS CONCEIVED (Brief outline of circumstances)

1/8/85 GEORGIA TECH CLASS

10. DATE AND PLACE OF FIRST SKETCH, DRAWING OR PHOTO

2/27/85 GEORGIA TECH LIBRARY

11. DATE AND PLACE OF FIRST WRITTEN DESCRIPTION

12. DISCLOSURE OF INVENTION TO OTHERS

NAME, TITLE AND ADDRESS	FORM OF DISCLOSURE	DATE AND PLACE OF DISCLOSURE	WAS SIGNATURE OBTAINED (YES OR NO)
NONE			

12.A IMPORTANT - HAVE ANY PUBLICATIONS OR REPORTS BEEN MADE ON THIS INVENTION?

YES

13. DATE AND PLACE OF COMPLETION OF FIRST OPERATING MODEL OR FULL SIZE DEVICE

N/A

14. PRESENT LOCATION OF MODEL

N/A

15. DATE, PLACE, DESCRIPTION AND RESULTS OF FIRST TEST OR OPERATION

N/A

16. NAMES AND ADDRESSES OF WITNESSES OF FIRST TEST

N/A

17. DATE, PLACE, DESCRIPTION AND RESULTS OF LATER TESTS (name witnesses)

N/A

18. IDENTIFY RECORDS OF TESTS AND GIVE PRESENT LOCATION OF RECORDS

N/A

19. PRIOR REPORTS OR RECORDS OF INVENTION TO WHICH INVENTION IS RELATED

N/A

20. OTHER KNOWN CLOSELY RELATED PATENTS, PATENT APPLICATIONS AND PUBLICATIONS

PATENT OR APPLICATION NO.	DATE	TITLE OF INVENTION OR PUBLISHED ARTICLE	NAME OF PUBLICATION
3,729,844	MAY 1, 1973	MULTIPURPOSE BULLDOZER BLADE	

21. EXTENT OF USE: PAST, PRESENT AND CONTEMPLATED (Give dates, places and other pertinent details)

CONTEMPLATED FOR USE BY NASA ON THE LUNAR SURFACE

22. DETAILS OF INVENTION HAVE BEEN RELEASED TO THE FOLLOWING COMPANIES OR ACTIVITIES

NAME AND ADDRESS	INDIVIDUAL OR REPRESENTATIVE	CONTRACT NO.	DATE
GEORGIA TECH	PROF. BRAZELL		

SIGNATURE OF INVENTOR Troy N. Cyr, et al. DATE 3/6/85

RECORD OF INVENTION - Part II

(Attach to Record of Invention Part I)

REC. OF
INV. NO. ______________

This Disclosure of Invention should be written up in the inventor's own words and generally should follow the outline given below. Sketches, prints, photos and other illustrations as well as reports of any nature in which the invention is referred to, if available, should form a part of this disclosure and reference can be made thereto in the description of construction and operation.

1. INVENTORS NAME(S) TIM AYERS, et. al.

2. TITLE OF INVENTION LUNAR SURFACE SITE PREPARATION APPARATUS

For answers to following questions use remainder of sheet and attach extra sheets if necessary.

3. GENERAL PURPOSE OF INVENTION. STATE IN GENERAL TERMS THE OBJECTS OF THE INVENTION.
4. DESCRIBE OLD METHOD(S) IF ANY, OF PERFORMING THE FUNCTION OF THE INVENTION.
5. INDICATE THE DISADVANTAGES OF THE OLD MEANS OR DEVICE(S).
6. DESCRIBE THE CONSTRUCTION OF YOUR INVENTION, SHOWING THE CHANGES, ADDITIONS AND IMPROVEMENTS OVER THE OLD MEANS OR DEVICES
7. GIVE DETAILS OF THE OPERATION IF NOT ALREADY DESCRIBED UNDER 6.
8. STATE THE ADVANTAGES OF YOUR INVENTION OVER WHAT HAS BEEN DONE BEFORE.
9. INDICATE ANY ALTERNATE METHODS OF CONSTRUCTION.
10. IF A JOINT INVENTION, INDICATE WHAT CONTRIBUTION WAS MADE BY EACH INVENTOR.
11. FEATURES WHICH ARE BELIEVED TO BE NEW.
12. AFTER THE DISCLOSURE IS PREPARED. IT SHOULD BE SIGNED BY THE INVENTOR(S), AND THEN READ AND SIGNED AT THE BOTTOM OF EACH PAGE BY TWO WITNESSES USING THE FOLLOWING STATEMENT:

"DISCLOSED TO AND UNDERSTOOD BY ME THIS______DAY OF_________19___
SIGNATURE_____________________________."

3. MOVING LUNAR SOIL

4. NONE

5. N/A

6. ELECTRIC / HYDRAULIC POWERED TRACKED DEVICE

7. OPERATED BY ONE (1) ASTRONAUT

8. N/A

9. N/A

10. TIM - HYDRAULICS
DALE - TRACKS
SUSAN - BATTERIES
RICH - MOTORS
MARK - BLADE

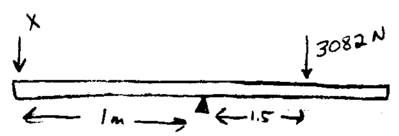
IRRADIATION ON MOON

SOIL DENSITY = 2000 kg/m^3
Al = 2701 kg/m^3
CAST IRON = 7920 kg/m^3
STAINLESS = 7820 kg/m^3

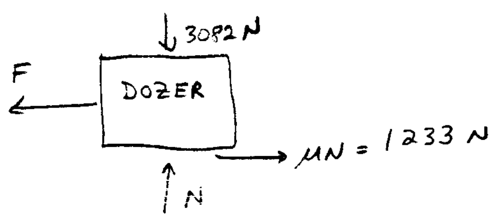
$\mu = .4$
$g_e = 9.8\ m/s^2$
$g_m = 1.63\ m/s^2$
DOZER → 3 m long
SCOOP → 1 m OUT FRONT

EARTH DOZER, MOSTLY CAST IRON ; STEEL
8,000 lbf = 35585 N ⇒ 3631 kg = .47 m^3
12,000 lbf = 53379 N ⇒ 5447 kg = .70 m^3

.47 m^3 Al = 1269 kg ⇒ 2068 N (ON MOON)
.70 m^3 Al = 1891 kg ⇒ 3082 N (ON MOON)



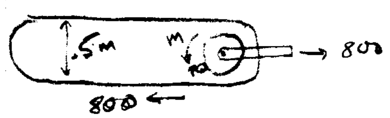
$(x) = 1.5\ (3082)$
$x = 4623\ N$ ⇒ 2836 kg ⇒ **1.42 m^3 SOIL**



$F_{SLIP} = 1233\ N$

$A_{BLADE} = (2m)(1m) = 2\ m^2$

$\frac{F}{A} = 616\ N/m^2$



1 ft·lb = 1.36 N·m

ASSUME: 4000 N ; $\mu = .5$
F = 2000 N
$F\theta$ = 500 N·m

500 N·m = 4046 lb.in.

2000 lb.in. ea. MOTOR

2 MOTORS - ea. PEAK

CHAR-LYNN SERIES 2000 WHEEL MOTOR
- 25 GPM
- 450 RPM
- 3590 lb.in.
- 2350 PSI
- 11.9 in^3/REV.

DUAL PUMPS
A10 V 40

PEAK 26 GPM
50 KW
2800 RPM

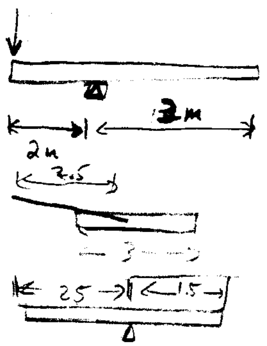
INPUT
40-50 KW

FINE SILTY SAND $2.0\ g/cm^3$

DENSITY $= 2000\ kg/m^3$

$\boxed{\mu = .4}$

$F = mg = 6520\ N$



$g_E = 9.8\ m/s^2$

$g_M = 1.63\ m/s^2$

$\frac{10^3\ g}{kg}$ $\frac{10^6\ cm^3}{m^3}$

$Al = 2701\ kg/m^3$
CAST IRON $= 7920\ kg/m^3$
STAINLESS $= 7820\ kg/m^3$

$(6520)(2.5) = (x)(.75)$

$x = 21733\ N \Rightarrow$ ~~6667 Kg ⇒ 2.5 m³~~

$\Rightarrow 5\ m^3$

8000 lb on earth

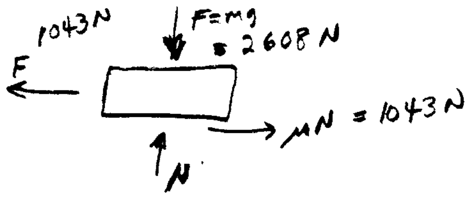
~~26,690~~ N → $35589\ N = m\ (9.8)$

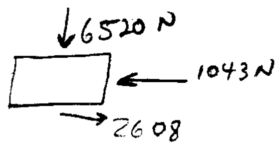
$F = mg$ $m = 3632\ kg \Rightarrow 5932\ N$

12000 lbf on earth ⇒ 5446 kg ⇒ LESS THAN 1 m³ of METAL

$\approx .6\ m^3$

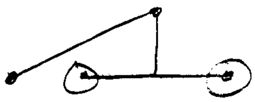
$\Rightarrow 1600\ kg$

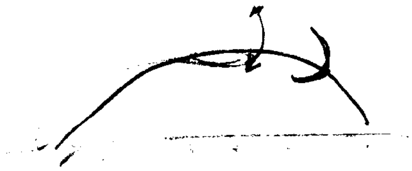


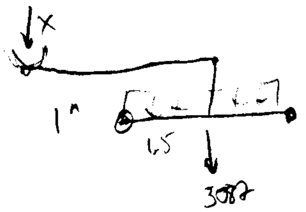


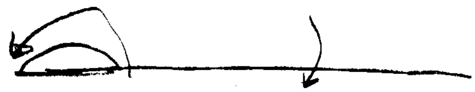
$\left(\frac{m}{s}\right)\left(\frac{mi}{5280\ ft}\right)\left(\frac{3600\ s}{hr}\right)\left(\frac{3.28\ ft}{m}\right)$

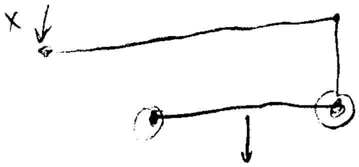
$\frac{3}{15}$ $\frac{1}{5}$ 2 3

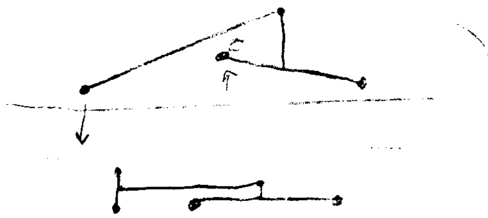


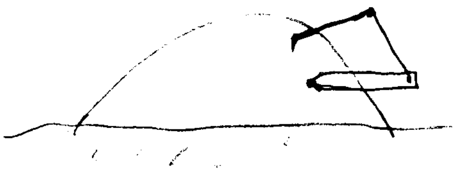


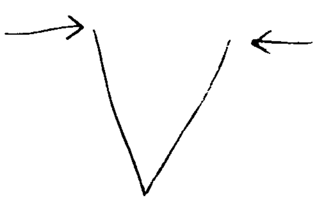

x
1"
1,5




x







POWER

NUCLEAR
BATTERIES } *
a.) SOLAR
b.) RECHARGEABLE
SOLAR
~~[illegible]~~
~~HYDROCARBON FUEL~~
ELECTRIC GENERATOR

DRIVE/ENGINE

~~I. C.~~ ~~[illegible]~~
D.C. MOTOR *
A.C. MOTOR
~~GAS TURBINE~~
~~STEAM~~
FLYWHEEL

TRACTION

✓TRACKS — STEEL, ~~Al~~, ~~CERAMIC~~, COMPOSITE
~~SPIKED WHEEL~~
~~[illegible]~~
~~HOLLOW WHEEL~~ *
WIRE MESH ✓
HOLLOW LARGE CYLINDER ✓
HOLLOW WHEEL

BLADE SYSTEM

HYDRAULICS *
ELEC. MOTOR

TRACKS ~~[illegible]~~ → UV INTENSITY
DEFINE LIFE EXPECTANCY 3–6 (MONTHS)
SUBTITLES FOR DESCRIPTION SECTION OF OUTLINE
COMPUTER USAGE → MICROPROCESSOR IN DESIGN
OR COMPUTER OPTIMIZATION

DEVICE	REASONS
GAS TURBINE	WEIGHT, CONSTANT SPEED, COMPLEX
I.C.	NO O_2, FUEL IS HEAVY, TEMP. PROBLEMS
STEAM	IS NO WATER ON MOON
HYDROCARBON	NEED O_2
NUCLEAR	?
SPIKED WHEEL	MAY NOT PENETRATE SOIL

SITE ± 10° FROM MOON'S EQUATOR

THURS
DISCUSS TRACTION
ASK ABOUT OUTLINE

MUST BE BETTER THAN PICKS & SHOVELS

P.T.O. SHAFT

~~[illegible]~~ CONTROLS.

SPECIFY PARTS (ACTUAL)
USE EXISTING STUFF
(FABRICATE STUFF)

ME 4182

From <u>Earthlike Planets - Surfaces of Mercury, Venus, Moon, Mars</u>

Bruce Murray, Michael C. Malin, Ronald Greeley

W.H. Freeman and Co. San Francisco

QB601.M86

---

2 types of terrain

1.) <u>terrae</u> - highly reflective, heavily cratered, rugged uplands

2.) <u>maria</u> - dark, smooth, lightly cratered lowlands - vast lava plains primarily composed of basalt - volcanic rock composed of iron and magnesium rich [illegible]

1 Lunar Day = 28 Earth Days

- The surface density is a bit more than that of water. It is porous and becomes denser & stronger at depths over a few centimeters.

- Fine grained to a depth of 18 cms, where a coarse-grained layer appears.

- Crust - 50-100 Km

- Little magnetic field

- <u>Density</u> Moon = 3.34 where earth = 1.0

- Max Tsurface = 101°C

MOON

Period of Revolution = 27.32 earth days
Rotation Period = 27.32
Inclination of axis = 6°41' relative to orbit about earth

~~E~~

equatorial diameter = 3476 km
Mass (Earth = 1) = .01226
Volume (Earth = 1) = .0203
Density (Water = 1) = 3.34
No atmosphere

Mean Temp at surface = 107°C day
-153°C night

Atmospheric pressure at surface = 0 millibars

Surface Gravity (Earth = 1) = .16 1/6 of earth

No Seasons on the moon.
Nearly uniform daily pattern of sunlight
Substantial areas near the poles - within craters and other depressions - that are permanently in shadow. Surface temps w/in these areas are estimated to be much below -238°C. Such localities on the Moon are among the coldest surface environments within the entire inner Solar System.

On the illuminated surface, Surface Temps are estimated at 130°C (max)

From ORBITING THE SUN Whipple
QB601.W6 1981

- Top Surface layers are made of very porous material.

- Surface is extraordinarily rough at dimensions of less than 1mm.

- The top material is mostly very fine grained, the grains being on the order of a few thousandths of a cm; interspersed with occasional rocks from pebble size upwards. The bearing strength is weak, so that astronauts walking on the surface leave clear-cut footprints a cm or so deep.

- Cuts in the surface leave rather vertical walls, indicating that the material has internal strength, but is weak, perhaps stronger than freshly plowed earth.

- When gouged, the surface tends to crack slowly in small blocks, confirming that it is a somewhat crunchy material.

<u>ie</u> not very compressible under mod Pressure suggesting an internal structure of some coherence.

"Soil" layer of impact-generated fragments, or regolith.
Regolith consists of rock fragments derived in place, pieces of ejecta, possibly an occasional altered fragment of a meteorite, and glass formed from impact melt.

The regolith-generating process can also compact the soil to form a new rock, composed entirely of rock fragments and soil. This rock is called breccia.

① DE81-028 084 Articles Referenced

Rapid Charging of Lead-Acid Batteries for Electric Vehicle Propulsion and Solar-Electric Storage.

- Paul Longrigg June 1981

In the rapid charging of lead acid batteries, 3 parameters of concern:

1.) time
2.) reliability of charge
3.) battery lifetime.

2 most attractive recharging methods in this paper:

1.) modified constant potential method
2.) resistance-free voltage charging

p29:
Some general criteria have been developed for battery storage systems in solar photovoltaic applications:

Deep Discharge Photovoltaic Battery Requirements:

System Voltage	160 to 240 V - (200V nominal)
Battery Voltage	6 to 12 volts
Capacity	15 to 50 KWh; nominal 25 KWh
Rate in Service	1 h rate max; 6 h rate nominal
Duty Cycle (Daily)	Discharge to 80% rated Capacity

Life	5 yr min
Energy η	80% minimum
Self Discharge	1% per week max
Temp Range	0 - +50°C

Shallow Discharge Requirements:

System Voltage	12-120 V
Battery Voltage	6-12 V
Capacity (8 hr rate)	25-2500 Ah at 25°C
Rate in service	8 h max
Duty Cycle - daily	5% of rated capacity
Duty Cycle - annual (4)	100% to 20% to 100%
Life	5 yr min
energy η	80% min
self discharge	1%/month max
Temp range	-40 to 60°C

Fast chargers charge to 80% full capacity in 10-15 min

~~(2) DE81 028235~~
~~Future of Electricity for Automobiles: Advanced Electric Vehicle Concepts~~

~~L.G. O'Connell Lawrence Livermore National Lab-~~
~~Transportation Systems Research~~
~~July, 1981~~

(3) SAND-80-0216

Implementation Plan (May 79): Batteries for Specific Solar Applications
R.P. Clark April '81

5 Major Tasks:
1. Battery Requirements Analysis
2. LAB Evaluation
3. Photovoltaic advanced systems tests
4. Photovoltaic Applications Exp.
5.) Battery R&D

- Electrochemical batteries are one of the most attractive energy storage systems for use w/ photovoltaics

I <u>Battery Requirements Analysis</u>

This analysis defines the role of battery storage systems used in conjunction w/ PV Systems.

<u>Load Data Definition</u> - Energy storage requirements for PV applications depend directly upon the solar availability / load usage match. Electrical load usage information has been compiled in previous studies

Initial Battery Requirements Analysis Report 2/80

Status Report Relating Battery SOA to Battery Requirements 6/80

81

(4) N82-22663

<u>Characterization of Solar Cells for Space applications</u>

Volume XIV

NASA - Jet Propulsion LAB - Cal Tech

<u>Cells</u> made by Hughes Research Lab.

The cells are made by growing a GaAs buffer layer by LPE or

All currents in mA/cm²
All Voltages mV
All Power Outputs mW/cm²
Temp °C, intensities mW/cm²

geometric dims in cm or microns

all efficiency, current, and power output data are on the basis of unit cell area.

~~Table~~

Fig 1 Short Circuit Current

at Irradiation of 100 mW/cm² $I_{sc} \approx 20$ mA/cm²

at Irradiation of 250 $I_{sc} \approx 50-55$

at Irradiation of 500 $I_{sc} \approx 100-110$

Fig 2 Open Circuit Voltage

at Irr of 100 V_{oc} [mV] = 1050 at T = −30°C

(linear) = 600 mV at T = 200°C

at Irr of 250 V_{oc} = 1100 at T = −20

= 650 at T = 200

at Irr of 500 V_{oc} = 1125 at T = −20

= 675 at T = 200°C

Fig 3 Max Power Current

at Irr of 100 mW/cm² I_{mp} = 17.5 mA/cm²

at Irr of 250 I_{mp} = 45

at Irr of 500 I_{mp} = 95

Fig 4 Max Power Voltage

at I = 100 V_{mp} = 850 mV at T = −20 °C

= 450 at T = 200 °C

at I = 250 V_{mp} = 930 mV at T = −20 °C

= 500 at T = 200

at I = 500 V_{mp} = 945 at T = −20

525 at T = 200

Figure 5 Max Power mW/cm²

at Irr = 100 mW/cm² P_{max} = 15 at T = -20 °C
= 10 at T = 200 °C

at Irr = 250 mW/cm² P_{max} = 42 at T = -20
= 24 T = 200

at Irr = 500 mW/cm² P_{max} = 86 at T = -20
= 50 at T = 200

Battery

Hughes LPE GaAs Cells (9/79) P/N Junction less than .5 microns.

Window less than .5 microns

2 x 2 x .0305 cm (sample size 7)

Volume XIV - Electrical Characteristics of Hughes Liquid Phase Epitaxy Gallium Arsenide Solar Cells as a function of Intensity, Temperature + Irradiation

Front Contact Material - Au-Zn followed by an Ag evaporation

Definition of Solar Cell

a pn junction device which converts the radiant energy of sunlight directly + efficiently into electrical energy.

United States Patent [19]
[illegible]

[11] 3,729,844
[45] May 1, 1973

[54] MULTI-PURPOSE BULLDOZER BLADE

[76] Inventor: [illegible] W. [illegible], 20440 70th Avenue, R.R. No. 4, Langley, B.C., Canada

[22] Filed: Mar. 11, 1971

[21] Appl. No.: [illegible]

[52] U.S. Cl. 37/117.5, 172/253, 172/801
[51] Int. Cl. ....[illegible] 3/76, A01b 63/00
[58] Field of Search....................172/801, 809, 806, 172/250–253; 37/117.5

[56] References Cited

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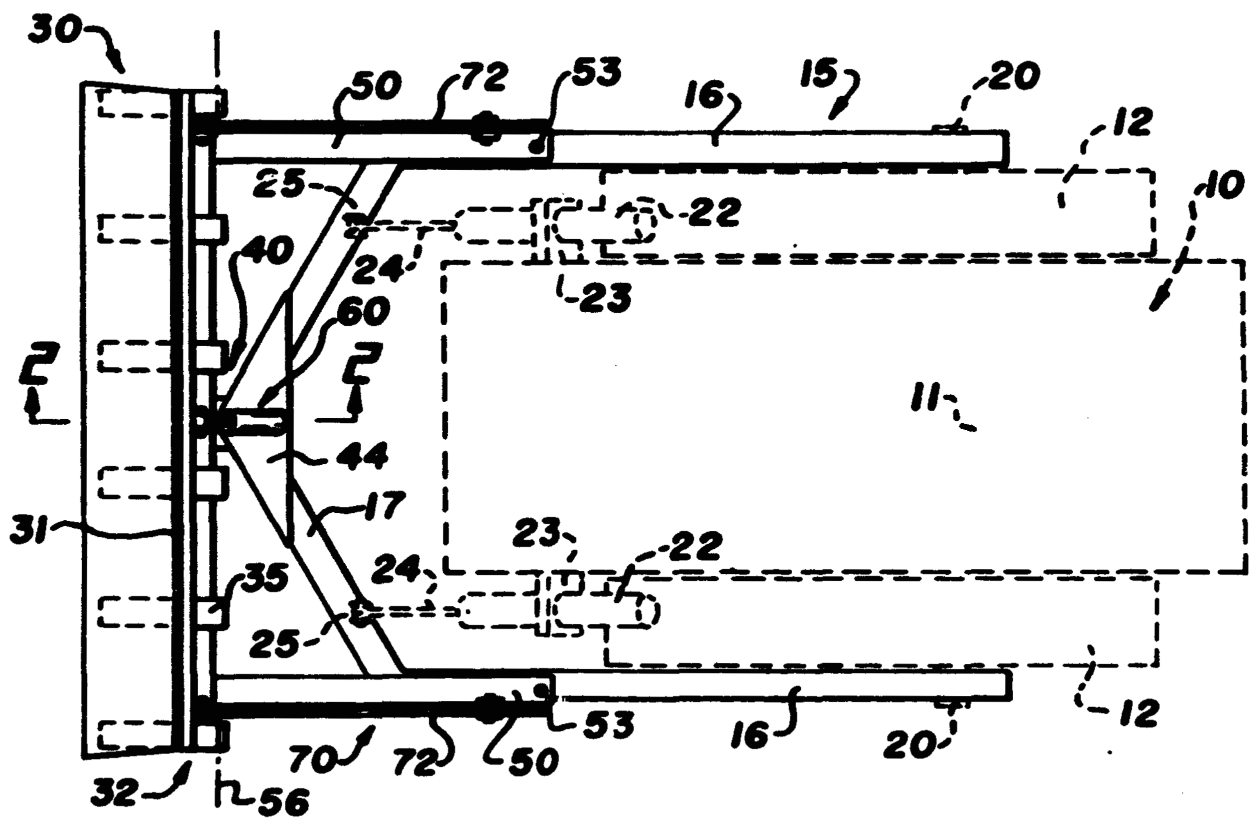
3,218,740	11/19[illegible]	White	37/117.5
2,[illegible]	11/19[illegible]	Smith	37/117.5

Primary Examiner—Robert E. Pulfrey
Assistant Examiner—Stephen C. Pellegrino
Attorney—Fetherstonhaugh & Co.

[57] ABSTRACT

An implement is provided for attachment to the front of an earth moving machine and is supported for rocking movement about a transverse axis and is vertically movable between a substantially ground level position and an elevated position about the machine. The arrangement enables the implement to function as a bulldozer blade, a scraper blade, or a loader bucket. Digging teeth are provided on the implement and a removable plate normally covers the teeth.

3 Claims, 7 Drawing Figures



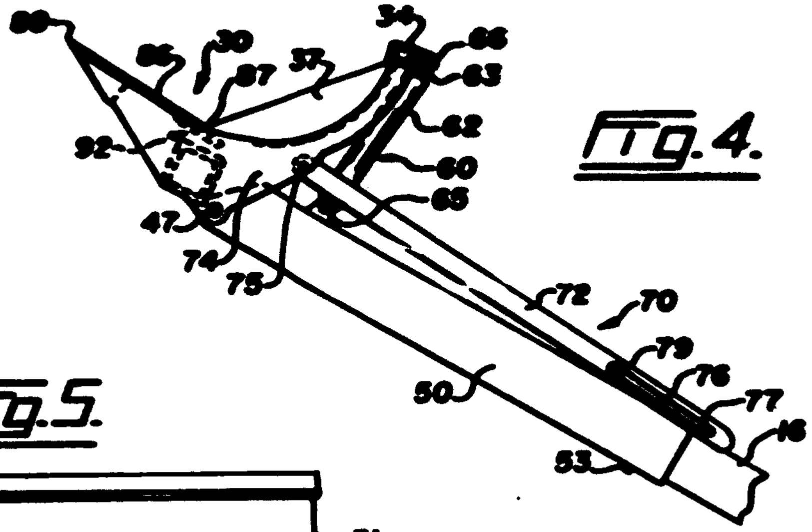


Fig. 4.

Fig. 5.

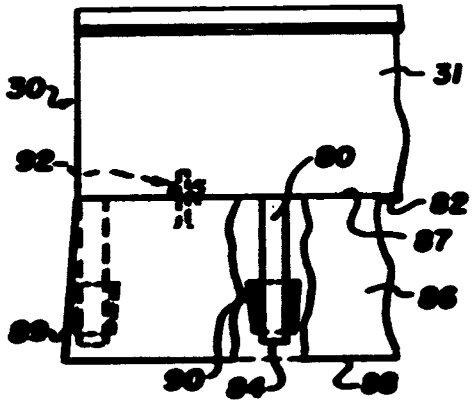


Fig. 6.

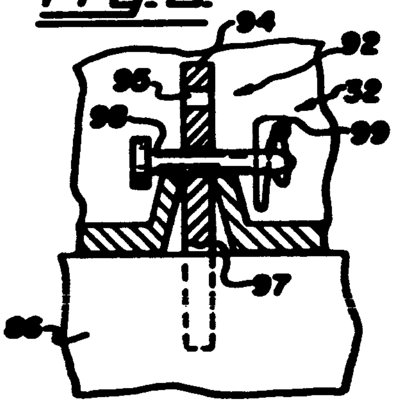
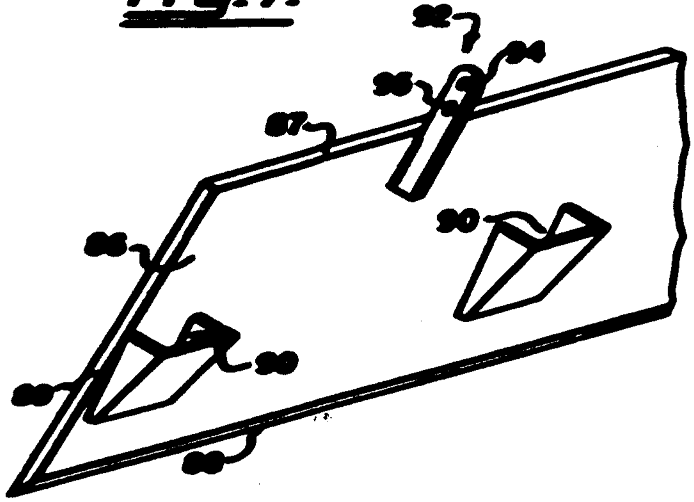


Fig. 7.



INVENTOR
HELMUT W. DEGLAN
BY
Fetherstonhaugh & Co.
ATTORNEYS

FIG. 1.

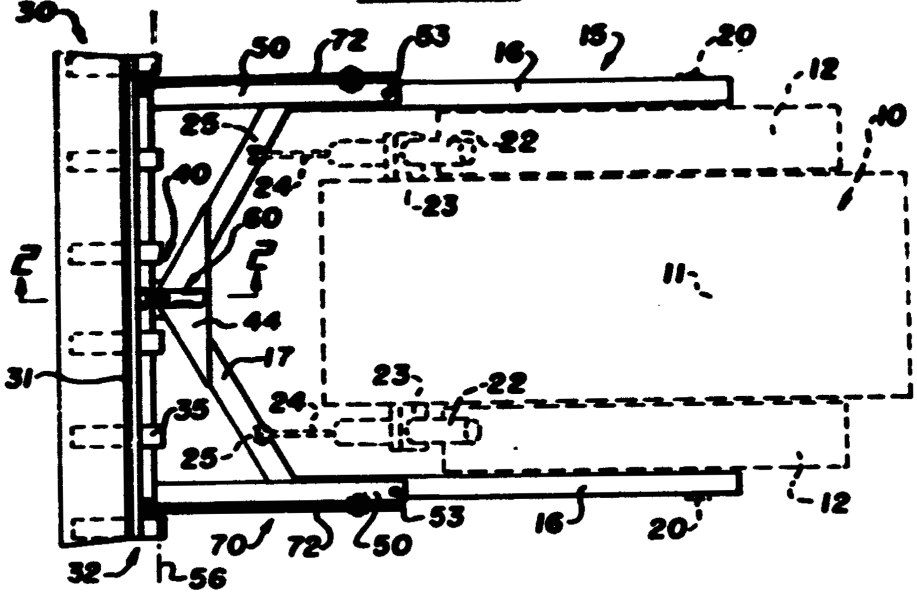


FIG. 2.

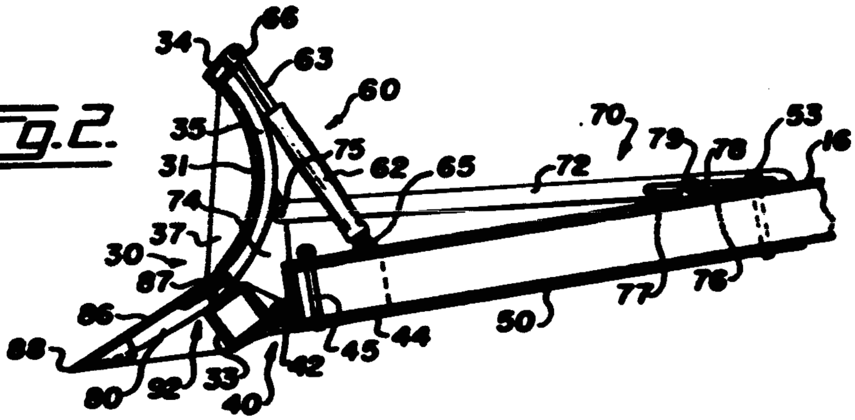
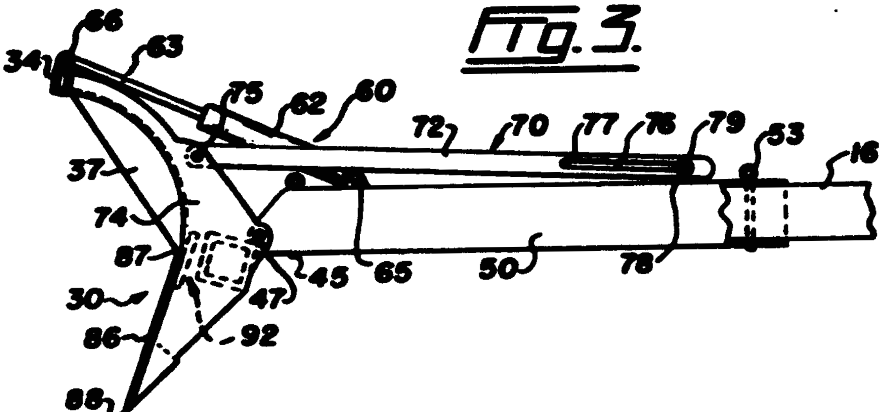


FIG. 3.



INVENTOR
HELMUT W. DEGLAN
BY
Fetherstonhaugh & Co
ATTORNEYS

MULTI-PURPOSE BULLDOZER BLADE

My invention relates to an implement which is attachable to a bulldozer to perform a variety of tasks.

A conventional bulldozer blade is designed to move earth and the like by shoving the material ahead of the machine with the lowermost edge of the blade digging into the earth to some extent. The blade does this type of work extremely well but very often conditions are encountered which require the use of a tool of different design. This may mean that the bulldozer has to move out of the way and stand idly by while a machine of appropriate design such as a shovel or a loader is moved up to perform the task which cannot be done with a conventional bulldozer blade. Obviously this employment of several expensive machines with their highly paid operators is an unsatisfactory one which contractors like to avoid if at all possible.

I have solved this particular problem by providing a bulldozer blade which will perform the task for which it was designed as effectively as before but, in addition, can be used as a grading blade or as a loading bucket. The present blade has a portion which is removable to expose the teeth suitable for use in clearing out rocks and roots as well as breaking up hardpan.

In drawings which illustrate a preferred embodiment of the invention;

FIG. 1 is a plan of a multi-purpose bulldozer blade mounted on a conventional tractor,

FIG. 2 is an enlarged vertical section taken on the line 2—2 of FIG. 1,

FIG. 3 is a side elevation of the blade in a grading position,

FIG. 4 is a side elevation of the blade in a load-carrying position,

FIG. 5 is a fragmentary front elevation of the blade supported in a scraping position,

FIG. 6 is a detailed view of locking means for securing an extension to the bulldozer blade, and

FIG. 7 is a perspective view of a portion of the moldboard extension as seen from the rear.

Referring first to FIG. 1, the numeral 10 indicates generally a bulldozer comprising a tractor 11 which is provided with crawler tracks 12. A C-frame 15, having parallel side members 16 and angularly disposed front member 17 straddles the tractor 11 to project forwardly therefrom. The frame (not shown) of the tractor 11 has laterally projecting trunnions 20 and the rear end of the side members 16 are journalled on these trunnions. Thus, the C-frame 15 is pivotally mounted on the tractor 11 for swinging movement about a transverse axis provided by the trunnions 20 and suitable means is provided for raising and lowering the front end of said frame. For example, the tractor 11 may have vertically swingable hydraulic cylinders 22 mounted on pivot blocks 23 or the like and having piston rods 24 pivotally connected as at 25 to the front members 17. When appropriate ends of the double-acting cylinders 22 are pressurized, the C-frame 15 is raised or lowered with the forward end of said frame moving vertically through an arc. The machine thus far described is of conventional construction and need not be exactly as described and illustrated as long as the front end of the C-frame 15 can be moved vertically in a suitable manner.

The multi-purpose blade which forms the basis of the present invention is generally indicated by the numeral 30. Blade 30 extends across the front members 17 of the C-frame 15 and is provided with a rearwardly curved moldboard 31 which projects beyond the side members 16. A heavy frame 32 is secured to the rear face of the moldboard 31 to give this relatively thin, plate-like member the necessary strength and rigidity and this frame includes transverse bottom and top members 33 and 34 which are connected by vertical ribs 35, see particularly FIGS. 1 and 2. The moldboard 31 is also braced by side plates 37 which are shown in FIGS. 2, 3 and 4. It will be noted that the moldboard 31 and side plates 37 give the bulldozer blade 30 a shape somewhat like a shallow bucket.

Pivot means generally indicated at 40 secures the blade 30 to the C-frame 15. As shown in FIGS. 1 and 2, the pivot means 40 comprises a pin 42 which is suitably mounted so as to connect the bottom member 33 of the moldboard frame with a housing 44. The substantially triangular-shaped housing 44 fits over the apex of the frame members 17 at the forward end of the C-frame 15. The housing 44 is secured to the C-frame 15 simply by means of a removable pin 45, see FIG. 2.

The pivot means 40 also includes two other pivot pins 47 which are aligned with the center pivot pin 42, one near each side edge of the blade 30. For convenience, only one of the side pivot pins 47 is shown in FIGS. 3 and 4. To support the pins 47, each side member 16 of the C-frame is fitted with a side channel 50. Each channel 50 fits over the side member 16 and is secured thereto by a removable pin 53, see FIG. 3 for example. Thus, the center pivot pin 42 and the two side pivot pins 47 secure the blade 30 to the C-frame 15 for rocking movement about a horizontal and transversely extending axis which is indicated by chain dotted line 56 in FIG. 1 only.

The blade 30 is adapted to be rocked about the pivot means 40 by power means generally indicated at 60. Preferably, the means 60 comprises a double-acting hydraulic cylinder 62 fitted with a piston rod 63. The centrally disposed cylinder 62 is pivotally secured as at 65 to the housing 44 as shown best in FIG. 2. Rod 63 is similarly secured as at 66 to the top member 34 of the moldboard frame 32. Cylinder 62 is included in a suitable hydraulic circuit (not shown) extending to the hydraulic system of the tractor 11 whereby the driver of the machine can rock the blade 30 as required about the axis 56 and thus control the operating angle of said blade. The blade 30 has three major operating positions which are the generally upright, ground level position shown in FIG. 2, the forwardly tilted, ground-level position shown in FIG. 3, and the raised and rearwardly tilted position shown in FIG. 4.

In order to relieve the strain of the power means 60 and associated parts when the blade 30 is in either the forwardly or rearwardly tilted positions, the present device includes stop means generally indicated at 70. As shown in FIG. 1, and in greater detail in FIG. 3 for example, the means 70 comprises a pair of arms 72 with one arm being disposed above each side channel 50. The front end of each arm 72 is connected to a bracket 74 on the moldboard frame 32 by a pivot pin 75 and the opposite end of said arm is provided with a longitudinal slot 76 having end edges 77. A bracket 78 is mounted on each side channel 50 near the rear end thereof and this bracket carries a laterally projecting pin 79 which slidably projects through a slot 76 in an adjacent arm. When the blade 30 is in the forwardly tilted position shown in FIG. 3, the two pins 79 are engaged by the rear end edges 77 of the slots 76 whereupon the blade 30 is partly supported by the pair of arms 72. In the same manner, the arms 72 partly support the blade when it is tilted rearwardly as in FIG. 4, the pin 79 at this time engaging the front end edges 77 of the slots 76.

Referring now to FIG. 5, the blade 30 will be seen to be provided with a plurality of digging teeth 80. These transversely spaced teeth 80 are secured to the bottom member 33 of the moldboard frame so as to extend downwardly and forwardly from lower edge 82 of the moldboard. As viewed in side elevation, the teeth 80 will be seen to taper from the member 33 to their outer ends 84.

The moldboard 31 is provided with an extension 86 which is a substantially rectangular plate covering the teeth 80. Extension 86 has an upper edge 87, a lower edge 88, and side edges 89 which preferably diverge from upper 87 to lower edge 88. On the rear face of the moldboard extension 86, a number of transversely spaced holding sockets 90 are formed, see particularly FIGS. 5 and 7, there being one such socket for each tooth 80. The teeth 80 are seated in the holding sockets 90 so that the moldboard extension is firmly held against movement in all directions except longitudinally of the teeth.

To hold the moldboard extension 86 from slipping forwardly off the teeth 80, the multi-purpose blade 30 is provided with locking means generally indicated at 92. As shown in FIG. 5, 6 and 7, the means 92 comprises a pair of bars 94 (one only illustrated) which are welded or otherwise secured to the rear face of the extension 86, one near each side edge thereof. The bars 94 are provided with one or more transversely extending holes 95. The bars 94 each project through a slot 97 (FIG. 6 only) which is formed in the frame 32 to the rear of the moldboard 31. A locking pin 98 is threaded through a suitably spaced hole 95 in each bar 94 to prevent the extension 86 from moving downwardly and forwardly off the teeth 80. Preferably, each locking pin 98 is secured against being accidentally dislodged from its bar 94 by means of a ringed keeper pin 99. Thus, the moldboard extension 86 is firmly locked to the remainder of the blade 30 so that it cannot be dislodged during normal operations.

In operation, the blade 30 is adapted to be positioned as shown in FIG. 2 whereupon it can be used as a conventional bulldozer blade. In this generally upright position, lower edge 88 normally is partially embedded in the ground as the blade is pushed forwardly by the tractor 11. A digging and scooping action then takes place and the blade 30 is used in much the same manner as the conventional bulldozer blade.

When tilted forwardly as shown in FIG. 3, the blade 30 can be used in the same manner as a scraper blade on a grading machine. This grading position of the blade 30 enables the machine 10 to function as a grader so that a road surface or the like can be leveled off without the lower edge 88 digging too deeply into the road surface. The hydraulic cylinder 62 is pressurized to maintain this grading position as it does the other three major operating positions of the blade but the pair of arms 72 also lend support the blade so that no undue stress is placed on the power means 60.

To pick-up and carry a load of earth or the like, the blade 30 is driven into the earth while in the digging (FIG. 2) position. The power means 60 is then actuated to tilt or rock the blade rearwardly as shown in FIG. 4 whereupon the C-frame 15 is raised by means of the cylinders 22 to elevate the blade and the load supported thereon. The earth load can be transported from place to place by the machine and can be dumped from the elevated and rearwardly tilted blade 30 into a truck, for example, simply by pressurizing the appropriate end of the cylinder 62 to rock the blade to the forwardly tilted position shown in FIG. 3.

The blade 30 can also be used to clear out roots and the like and for this purpose, the moldboard extension 86 is removed to expose the teeth 80. The blade is then tilted to the FIG. 3 position whereupon the end of the teeth can be embedded in the ground to a depth which will dig out roots when the bulldozer 10 is moved forwardly.

It will be noted that the blade 30 can quickly and easily be removed from the C-frame 15. This is done by pulling out the pins 45 and 53 to release the blade from the tractor which is then driven in reverse to back the side members 16 out of the channels 50 and withdraw the front members 17 from the housing 44. The blade 30 can be picked up by reversing this procedure and generally this can be done by the tractor operator working without assistance.

The moldboard extension 86 can also be removed and replaced without difficulty. To remove the extension 86, the tractor operator merely loosens the locking pins 98 and then manipulates the blade to drop the extension on to the ground. Replacement is slightly more difficult but a skilled operator soon learns to use the blade 30 to jockey the extension into a position where the teeth 80 can be thrust into the holding sockets 90 and, when this is done, it is a simple matter to thread the locking pins 98 into the holes 95 which serves to lock the extension to the remainder of the blade.

From the foregoing, it will be seen I have provided a simple yet extremely effective bulldozer blade which will function equally as well as a scraper, a tooth digging implement, a conventional blade, or a loader bucket. The apparatus can readily be attached to or removed from a bulldozer C-frame and the power requirement of the device can be supplied by adding a few extra hose lines and a control valve to the hydraulic system of a conventional tractor.

I claim:

1. A multi-purpose blade for a bulldozer having a vertically swingable C-frame, said blade comprising a moldboard extending across a front end of the C-frame, pivot means securing the moldboard to the C-frame for rocking movement about a horizontal and transversely extending axis, said moldboard having a lower edge, a plurality of digging teeth extending downwardly from the lower edge, a moldboard extension detachably secured to the moldboard to cover the digging teeth, said moldboard extension having holding sockets to receive the digging teeth, locking means for detachably securing the moldboard extension to the moldboard,

said locking means comprising a bar extending upwardly from the moldboard extension, said moldboard having a frame provided with a slot through which the bar projects, and a locking pin extending transversely through an opening in the bar to prevent withdrawal of said bar from the slot, and power means including a fluid cylinder and piston rod therefore for rocking the moldboard about the axis to a selected operating position, one such position being a forwardly tilted grading position, another being a generally upright digging position, and still another being a rearwardly tilted load-carrying position.

2. A multi-purpose blade as claimed in claim, 1 and including stop means for limiting rocking movement of the moldboard beyond the forwardly tilted grading position and the rearwardly tilted load-carrying position.

3. A multi-purpose blade as claimed in claim, 1 in which said pivot means and said power means are mounted on C-frame supported members, and a removable pin securing each of the members to the C-frame.

* * * * *

HYDRAULIC PUMPS / MOTORS

1 8226 - 1230
2 8074 - 0123
3 6074 - 1265 , 2228
4 6763 - 0135
5 8585 - 3975
6 8586 - 4328
7 8951 - 2009
8 85 83 - 3680

PUMPS

8062 - 0041
6787 - 0744
8071 - 0097
6058 - 2800
8222 - 1200
8076 - 1589 → -5°F → 180°F

REXROTH - HYDRAULIC PUMPS.

5. TYRONE PS-200 80 HP INPUT 2000 RPM 2500 PSI
GEAR PUMPS P16-200 (SAME BUT LIGHTER WEIGHT)

6. ROTARY POWER
HYDRAULIC MOTORS 5000 PSI INPUT 1340 ~~ft~~ lbs (out)
SINGLE SPEED 60 HP

1. BENDIX
HYDRAULIC PUMPS - VARIABLE PRESSURES FOR AIRPLANE ACTUATORS

2. HIGH PRESSURE EQUIP. VALVES, SAFTEY VALVES
ADAPTORS, COUPLINGS, ELBOWS,

3. INGERSOLL-RAND GENERAL SERVICE PUMPS - WATER, ETC.

4. BERKELEY - WELL PUMPS

7. TRW ; ROSS GEAR - HYDRAULIC MOTORS CYLINDERS
TOO SMALL

8. EATON
WHEEL MOTORS - (INSIDE WHEELS) 600 RPM
3150 in lbs OR 5500 in lbs
3300 PSI

(BEST SELECTION OF MOTORS)

$\boxed{450 \text{ RPM}} \times \pi/30 = (47 \text{ r/s})(.25\text{m}) = 11.75 \text{ m/s} = 25.6 \text{ mi/hr}$

$\boxed{2000 \text{ in.lb}}$

CHAR-LYNN "H" SERIES

10.3 in^3/rev

$\left.\begin{array}{l}\text{320 RPM} \\ \text{15 GPM} \\ \text{2180 in lb.} \\ \text{1800 PSI}\end{array}\right\}$ PEAK

2 MOTORS

\# 101-1052

PUMP

NEED $\left.\begin{array}{l}\text{40 GPM} \\ \text{2000 psi}\end{array}\right\}$ PEAK

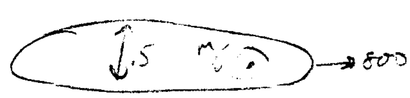
USE ONE

A 10 V 40 → VARIABLE DISPLACEMENT PUMP

PEAK : 28 GPM

50 KW = 67 HP

2800 RPM



F·r = M

(800)(.25) = 200 N·m

147 ft lb

1764 in. lb.

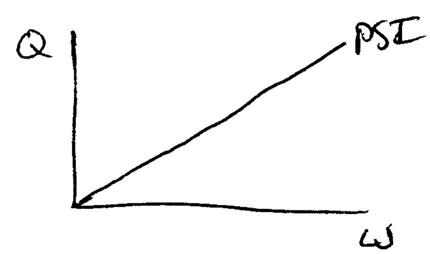
$\boxed{882 \text{ in.lb. ea. motor}}$

A10V25

POWER CONSUMPTION

20 KW @ 3000 PSI & 1800 RPM 10.6 GPM

35 KW @ 3000 PSI & 3250 RPM 18.5 GPM



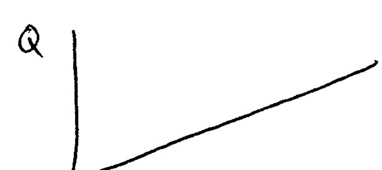
2 P2-6 PUMPS

15 HP REQ.

@ 2000 PSI

& 4000 RPM

11 GPM ea.



\#1 #2 #

1 2 3 30-35

CONST. = 1500 — 2500

VARI = 50 - 4000

I Engine
A Engine make + model
B Fly wheel HP
C Governed rpm

II No. of gears
A Transmission Type
B Forward
C Reverse

III max speed
A Forward
B Reverse
* C Max. Drawbar pull
* D Max Drawbar Hp

IV Dimensions
A Overall length
B Overall Width
C Overall Height
D Ground Clearance
E Unit weight

V Length of Track on ground
A Track gauge
B Standard shoe width
C soft ground
D hard ground

VI Ground Bearing Pressure
A soft Ground
B Hard Ground

VII. Hydraulic
A. Pump output
B. Pressure

VIII Dozer Blade
A. Method of operation
B. Blade Width
C. Blade Height
D. Blade side Angle
E. Blade tilt
f. Blade pitch
g. Height of lift
h. Drop Below ground
I. ripper
J. Winch
K. CCU
L. PTO

1 curvature of blade Civil Engineering
2 swing of blade
3 ~~loader capability~~
4 Type of earth to be moved
Both 5 Hydraulic vs. electric motors w/ chain drive or telescope
6 Suggestions for more Infon on exsisting equiptment

Type, amount, weight of earth to be moved

The Moon – geology

SAE Hand Book

road scrapper
jet air craft

La Terno
L.G. Le Tourneu

Updated 1-22-84

No answer; abandoning call

Remote disconnect
You may now enter GTNet commands
>D A ?
>A
No such virtual circuit
>A A
No such virtual circuit
>
>
>LO ?
CM 172/701.1
Clsf selected: 172/701.1
Number of patents: 40

~~1. 4,369,847 XR~~
~~2. 4,360,900 XR~~
3. 4,309,142 XR
4. 4,306,625 XR
5. 4,270,617 XR Blade
~~6. 4,082,150 XR~~
~~7. 4,040,725 OR~~
~~8. 4,024,922 XR~~
9. 3,974,882 OR Standard
~~10. 3,790,085 XR~~

Classification Mode-L 11-40

11. 3,729,044 XR #1
~~12. 3,465,027 XR~~
~~13. 3,432,947 XR~~
~~14. 3,310,740 XR~~
~~15. 3,121,964 XR~~
16. 3,104,480 XR
17. 3,028,698 XR
18. 3,028,692 XR
19. 2,891,334 XR
~~20. 2,841,097 XR~~
21. 2,763,944 XR
22. 2,763,943 XR
~~23. 2,701,591 XR~~
24. 2,674,817 XR
25. 2,633,164 XR
26. 2,494,225 XR
~~27. 2,338,124 XR~~
28. 2,219,159 XR
29. 2,147,193 XR
~~30. 1,969,204 XR~~
31. 1,944,307 XR
~~32. 1,853,115 OR~~
~~33. 1,586,229 OR~~
34. 1,492,885 XR
35. 1,406,325 OR
~~36. 1,337,548 XR~~
37. 1,249,264 OR
38. 851,712 XR
39. 588,959 OR
40. 523,134 XR

Classification Mode-D15/23
Clsf selected: D15/23
Number of patents: 154

~~1. 4,464,093 XR~~
~~2. 4,430,592 XR~~
~~3. 4,402,549 XR~~
~~4. 4,395,191 XR~~
~~5. 4,395,189 XR~~
~~6. 4,379,568 XR~~
~~7. 4,376,412 XR~~
~~8. 4,369,789 XR~~
~~9. 4,074,786 XR~~
~~10. 4,040,497 XR~~

Classification Mode-L 11-154

~~11. 3,972,158 XR~~
~~12. 3,744,057 XR~~
~~13. 3,712,664 XR~~
~~14. 3,701,393 XR~~
~~15. 3,654,807 XR~~
~~16. 3,656,799 XR~~
~~17. 3,561,705 XR~~
18. 3,527,315 XR
19. 3,421,589 XR
20. 3,297,096 XR
21. 3,168,149 XR
22. 3,138,883 XR
23. 3,127,688 XR
24. 3,115,716 XR
25. 3,111,779 XR
26. 3,057,428 XR
27. 3,049,819 XR
28. 2,965,990 XR
29. 2,869,304 XR
83. D 224,588 OR
84. D 224,525 OR
85. D 224,298 OR
86. D 222,783 OR
87. D 222,770 OR
88. D 222,692 OR
89. D 216,011 OR
90. D 214,434 OR
91. D 213,682 OR
92. D 213,312 OR
93. D 212,415 OR
94. D 211,569 OR
95. D 209,138 OR
96. D 209,135 OR
97. D 208,697 OR
98. D 205,352 OR
99. D 205,208 OR
100. D 203,164 OR
101. D 201,127 OR

30. 2,855,060 XR
31. 2,786,305 XR
32. 2,618,509 XR
33. 2,401,796 XR
34. 2,301,152 XR
35. 2,298,450 XR
36. 2,209,804 XR
37. 2,149,949 XR
38. 1,782,992 XR
39. D 274,524 OR
40. D 272,826 XR
41. D 272,825 XR
42. D 271,876 OR
43. D 270,350 OR
44. D 269,260 XR
45. D 266,340 XR
46. D 264,472 OR
47. D 261,141 OR
48. D 258,824 OR
49. D 258,509 OR
50. D 256,921 OR
51. D 256,801 XR
52. D 256,017 OR
53. D 251,088 OR
54. D 249,042 OR
55. D 247,814 OR
56. D 247,624 OR
57. D 247,362 OR
58. D 247,037 OR
59. D 245,982 OR
60. D 245,605 OR
61. D 245,604 OR
62. D 243,270 XR
63. D 242,940 XR
64. D 238,955 XR
65. D 238,798 XR
66. D 237,995 OR
67. D 232,374 OR
68. D 231,557 OR
69. D 231,248 OR
70. D 231,006 OR
71. D 230,417 XR
72. D 230,300 XR
73. D 230,298 OR
74. D 227,288 OR
75. D 227,243 OR
76. D 227,090 OR
77. D 227,089 OR
78. D 226,558 OR
79. D 226,557 OR
80. D 225,521 OR
81. D 225,000 OR
82. D 224,680 OR

102. D 200,966 XR
103. D 200,766 OR
104. D 200,302 OR
105. D 197,964 OR
106. D 197,557 OR
107. D 195,833 OR
108. D 194,349 OR
109. D 193,180 OR
110. D 193,135 OR
111. D 192,794 XR
112. D 191,702 OR
113. D 190,366 OR
114. D 189,812 OR
115. D 189,529 OR
116. D 188,840 OR
117. D 188,456 OR
118. D 188,313 OR
119. D 187,641 OR
120. D 186,939 XR
121. D 186,159 XR
122. D 185,233 OR
123. D 184,216 OR
124. D 182,373 OR
125. D 182,147 OR
126. D 178,603 OR
127. D 175,866 OR
128. D 172,576 OR
129. D 171,178 OR
130. D 170,956 OR
131. D 170,358 OR
132. D 169,982 OR
133. D 157,432 XR
134. D 155,818 OR
135. D 148,299 OR
136. D 148,040 OR
137. D 146,947 OR
138. D 142,365 OR
139. D 142,251 OR
140. D 139,635 OR
141. D 131,591 OR
142. D 130,786 OR
143. D 119,824 OR
144. D 116,320 OR
145. D 116,307 OR
146. D 114,112 OR
147. D 113,555 OR
148. D 113,554 OR
149. D 58,466 OR
150. D 58,280 OR
151. D 55,225 OR
152. D 54,807 OR
153. D 53,898 OR
154. D 53,627 OR

Classification Mode-D15/24
Clsf selected: D15/24
Number of patents: 59

1. ~~4,464,093~~ XR
~~2. 4,397,481 XR~~
~~3. 4,376,612 XR~~
~~4. 3,744,181 XR~~
*5. 3,741,331 XR Tracks
*6. 3,601,212 XR Tracks
~~7. 3,595,332 XR~~
~~8. 3,452,888 XR~~
~~9. 3,452,887 XR~~
*10. 3,412,819 XR Power source

Classification Mode-L 11-59

~~11. 3,112,573 XR~~
~~12. 3,002,574 XR~~
~~13. 2,837,844 XR~~
~~14. 2,777,918 XR~~

36. D 213,437 OR
37. D 210,521 OR
38. D 210,200 OR
39. D 209,137 OR

~~15. 2,770,7[illegible] XR~~
~~16. 2,678,103 XR~~
17. 2,613,912 XR
18. 2,182,781 XR
~~19. 1,932,100 XR~~
20. 1,812,543 XR
21. 1,741,878 XR
~~22. 1,477,348 XR~~
23. D 274,621 OR
24. D 274,333 OR
25. D 273,384 OR
26. D 271,396 OR
27. D 263,051 OR
28. D 258,887 OR
29. D 252,274 OR
30. D 251,845 OR
31. D 244,443 XR
32. D 238,195 XR
33. D 230,621 OR
34. D 230,620 OR
35. D 225,986 OR

40. D 208,693 OR
41. D 197,510 XR
42. D 197,056 XR
43. D 190,803 OR
44. D 188,044 OR
45. D 187,915 OR
46. D 187,582 OR
47. D 184,160 OR
48. D 182,386 OR
49. D 177,078 OR
50. D 164,896 OR
51. D 143,353 OR
52. D 141,135 OR
53. D 123,959 OR
54. D 116,319 OR
55. D 111,156 OR
56. D 111,155 OR
57. D 111,154 OR
58. D 101,846 OR
59. D 59,422 XR

Classification Mode-D15/25
Clsf selected: D15/25
Number of patents: 117

~~1. 4,464,093 XR~~
~~2. 4,379,568 XR~~
~~3. 4,376,612 XR~~
~~4. 4,369,989 XR~~
~~5. 4,055,255 XR~~
~~6. 3,976,146 XR~~
~~7. 3,893,728 XR~~
~~8. 3,858,661 XR~~
~~9. 3,831,690 XR~~
10. 3,828,952 XR Bodcat

Classification Mode-L 11-117

~~11. 3,807,586 XR~~
~~12. 3,744,181 XR~~
~~13. 3,741,331 XR~~
14. 3,732,995 XR
~~15. 3,732,780 XR~~
16. 3,601,212 XR
17. 3,441,155 XR
18. 3,441,154 XR
~~19. 3,421,389 XR~~
20. 3,289,331 XR
~~21. 3,197,188 XR~~
~~22. 3,163,744 XR~~
~~23. 3,138,883 XR~~
24. 3,112,573 XR
25. 3,057,090 XR
26. 3,035,724 XR
27. 3,022,911 XR
28. 3,016,636 XR
29. 3,015,497 XR
30. 2,973,874 XR
31. 2,946,564 XR
32. 2,941,319 XR
33. 2,914,868 XR
34. 2,903,142 XR
35. 2,888,088 XR
36. 2,878,951 XR
37. 2,799,411 XR
38. 2,795,458 XR
39. 2,791,341 XR
40. 2,777,219 XR
41. 2,644,284 XR
42. 2,635,868 XR
43. 2,613,912 XR
44. 2,585,095 XR
45. 2,560,674 XR
46. 2,535,727 XR

65. D 262,973 XR
66. D 259,631 XR
67. D 256,466 XR
68. D 251,845 XR
69. D 247,814 XR
70. D 245,503 OR
71. D 244,443 XR
72. D 235,113 OR
73. D 231,482 OR
74. D 230,622 OR
75. D 227,092 OR
76. D 226,707 OR
77. D 220,173 OR
78. D 220,172 OR
79. D 218,740 OR
80. D 218,739 OR
81. D 217,661 OR
82. D 216,963 OR
83. D 213,869 OR
84. D 211,522 OR
85. D 205,762 OR
86. D 205,485 OR
87. D 203,668 OR
88. D 202,717 OR
89. D 201,451 XR
90. D 201,176 OR
91. D 201,126 OR
92. D 196,500 OR
93. D 195,329 OR
94. D 195,254 OR
95. D 194,663 OR
96. D 193,503 OR
97. D 192,317 OR
98. D 191,306 OR
99. D 189,024 OR
100. D 187,914 OR

47. 2,501,797 XR
48. 2,495,144 XR
49. 2,490,155 XR
50. 2,482,692 XR
51. 2,444,692 XR
52. 2,441,070 XR
53. 2,425,746 XR
54. 2,421,904 XR
55. 2,357,954 XR
56. 2,196,037 XR
57. 2,182,781 XR
58. D 275,107 OR
59. D 274,333 XR
60. D 273,384 XR
61. D 272,826 OR
62. D 272,825 OR
63. D 271,397 OR
64. D 271,396 XR

101. D 184,629 OR
102. D 184,598 OR
103. D 184,241 OR
104. D 175,391 OR
105. D 172,069 OR
106. D 165,594 OR
107. D 165,320 OR
108. D 164,895 OR
109. D 163,884 OR
110. D 163,298 OR
111. D 163,161 OR
112. D 162,850 OR
113. D 157,453 OR
114. D 157,452 OR
115. D 155,815 OR
116. D 150,092 OR
117. D 132,742 OR

Classification Mode-D15/32
Clsf selected: D15/32
Number of patents: 58

~~1. 4,280,784 XR~~
~~2. 4,123,841 XR~~
~~3. 4,023,670 XR~~
~~4. 4,002,147 XR~~
~~5. 3,234,669 XR~~

~~6. 3,214,130 XR~~
~~7. 3,292,224 XR~~
~~8. 3,049,819 XR~~
~~9. 3,042,233 XR~~
~~10. 2,864,184 XR~~

Classification Mode-L 11-58

~~11. 2,834,489 XR~~
~~12. 2,832,187 XR~~
~~13. 2,774,155 XR~~
14. 2,584,868 XR
~~15. 2,556,409 XR~~
16. 2,417,021 XR
~~17. 2,373,710 XR~~
~~18. 2,145,663 XR~~
~~19. 1,959,847 XR~~
~~20. 1,864,793 XR~~
21. D 274,622 OR
22. D 274,525 OR
23. D 274,251 OR
24. D 269,515 OR
25. D 249,088 OR
26. D 248,558 OR
27. D 248,302 OR
28. D 246,845 OR
29. D 246,176 OR
30. D 245,984 OR
31. D 245,780 OR
32. D 243,326 XR
33. D 242,162 OR
34. D 241,264 OR

35. D 239,194 OR
36. D 237,293 OR
37. D 237,292 OR
38. D 219,809 OR
39. D 218,516 OR
40. D 216,874 OR
41. D 214,833 OR
42. D 207,258 OR
43. D 204,246 OR
44. D 191,939 OR
45. D 187,980 OR
46. D 180,494 OR
47. D 167,758 OR
48. D 162,873 OR
49. D 159,160 OR
50. D 144,738 OR
51. D 141,948 OR
52. D 141,272 OR
53. D 141,271 OR
54. D 141,133 OR
55. D 141,132 OR
56. D 140,280 OR
57. D 135,828 OR
58. D 20,906 OR

Classification Mode-Q
Thank you for using Cassis.
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12340 CHARACTERS OUTPUT
CONNECT TIME 0 HRS. 5 MIN.
28/01/85 LOGGED OUT AT 10.45.05.
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